TECHNICAL NOTE NO. LWL-CR-02F71A

40mm FLOATING FLARE DEVELOPMENT

Final Report
Contract No. DAAD05-72-C-0179

By
Donald W. Renfroe
Chemtronics, A Division of Airtronics, Inc.
Swannanoa, North Carolina 28778

March 1973

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

U. S. ARMY LAND WARFARE LABORATORY
Aberdeen Proving Ground, Maryland 21005

LWL
CR-02F71A
c.1

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

ABSTRACT

The 40mm Floating Flare can be launched from either the M79 or the M203 Grenade Launcher and provides troops with a standoff capability for marking a target or position in inundated areas during hours of darkness. The flotation capability is achieved by a flare-inflated, donut-shaped "ballute" which also acts as an aerodynamic decelerator to prevent the units from burying in mud or snow at impact.

The objectives of this program were (1) to improve the color output of the green flare, (2) to improve the transfer from the first fire (ignition) mix to the main flare mix (all colors...red, yellow, and green), and (3) to fabricate quantities for engineering design testing and field evaluation. The specific objectives were achieved during the course of a three-phase effort and a total of 1528 cartridges were delivered to the Government.

FOREWORD

This report was prepared for the U. S. Army Land Warfare Laboratory, Aberdeen Proving Ground, Maryland, by Chemtronics, a Division of Airtronics, Inc. This report presents the results of the program conducted under Contract DAAD05-72-C-0179 during the period of February 1972 through March 1973. The LWL Contract Technical Supervisor was Mr. Neal C. Wogsland. Contributors to the work reported herein not listed as authors were Mr. D. Campbell and Dr. C. D. Alley.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The objective of this program was to continue the development of the 40MM Floating Flare, especially to improve the color output of the green flare and to improve the transfer from the first fire (ignition) mix to the main flare mix (all colors), followed by the fabrication of quantities for engineering design testing and field evaluation. This grenade will broaden the Army's flare capability to include marking a target or position in inundated areas during hours of darkness.

The primary technical requirements for the floating flare as specified in the Statement of Work of Contract No. DAAD05-72-C-0179 was to provide a "greener" green flare, with "stoplight green" as the development goal. This investigation could have included consideration of using a shorter signal duration to determine if an acceptable tradeoff could be achieved. The second major emphasis was to improve the system reliability by improving the ignition transfer from the first fire to the main flare mix. The other design and performance goals, which were basically the same as those stated in Contract No. DAAD05-71-C-0191, are as follows:

1. The 40MM Floating Flare shall be developed as a 40MM cartridge, with all components assembled as a single unit.

2. This flare shall be designed for delivery from both the M79 and the M203 Grenade Launchers.

3. This flare design shall incorporate the 40MM Cartridge Case XM195 for the launch system.

4. Flare colors required are red, green, and yellow.

5. The flare design shall incorporate a flotation device of the ballute type, which shall be fabricated from a material capable of withstanding the high temperatures of the burning flare mix.

6. The cubic measurements shall be the same as those of the 40MM Floating Smoke Marker. The final assembly length shall not exceed 5 1/4 inches.

7. The projectile and total cartridge weights shall be consistent.

8. The cartridge shall be man-air transportable and have paradrop capability.

9. The cartridge shall be expendable.

10. The recoil momentum produced by the flare cartridge shall not exceed 4.0 lb-sec when fired from the M79 Grenade Launcher.

11. The flare cartridge shall be capable of operations in climatic conditions covered by Categories 1, 2, 5 and 6, of AR 70-38 dated 5 May 1969. Operation under all environmental categories is desired.

12. The flare delay element (fuse) shall initiate the signal emitting pyrotechnic before impact and preferably near the top of the trajectory when the flare is fired for maximum range.

13. Ballute inflation shall be complete between the time of separation of the payload from the projectile body and impact onto the water's surface when the flare is fired for maximum range.

14. The flare shall be capable of floating and functioning on mud or water of any depth and under all weather conditions.

15. The flare shall have a minimum range of 250 meters; 300 meters would be desirable.

16. The pyrotechnic mix shall produce a visible signal for a minimum of 1-1/2 minutes. (Note: See previous statement on possible tradeoff.) Duration shall be measured between the time of payload ignition (at

separation from the projectile body) to burnout after impact. The signal intensity and color shall be relatively uniform during this interval.

17. The flare signal shall be visible, and the color identifiable from an observation distance of at least 3000 meters from a minimum altitude of 1000 feet on a clear night.

18. The flare shall operate with 95 percent reliability in inundated areas.

19. The flare cartridge should be impact insensitive to small arms fire.

20. The flare cartridge shall have a storage shelf life of a minimum of five years.

21. Human Engineering Characteristics: Require no special training and complete safety in operation.

22. Maintenance Concept: Require no maintenance other than visual inspection prior to use.

23. Priority of Characteristics: reliability; performance.

The design of the floating flare is shown in Figure 1. Figure 2 illustrates the operation of the floating flare. The 40MM Flare may be launched from either the M79 or the M203 40MM Grenade Launcher. Approximately five seconds after the firing, the output of the fuse delay ignites the flare mix first fire. The resultant pressure generated inside the projectile body releases the snap joint on the ogive, thereby ejecting the ballute/flare canister assembly from the body of the projectile. Gases from the flare mix inflate the ballute instantaneously. The inflated ballute, acting as an aerodynamic decelerator, slows the descent rate of the flare. At the reduced descent rate and with its large frontal area, the flare will impact so gently in shallow water that it will not bury itself in soft mud below the surface. The design improvements of the floating flare, the flare compositions, and overall performance parameters are described in detail in the development sections.

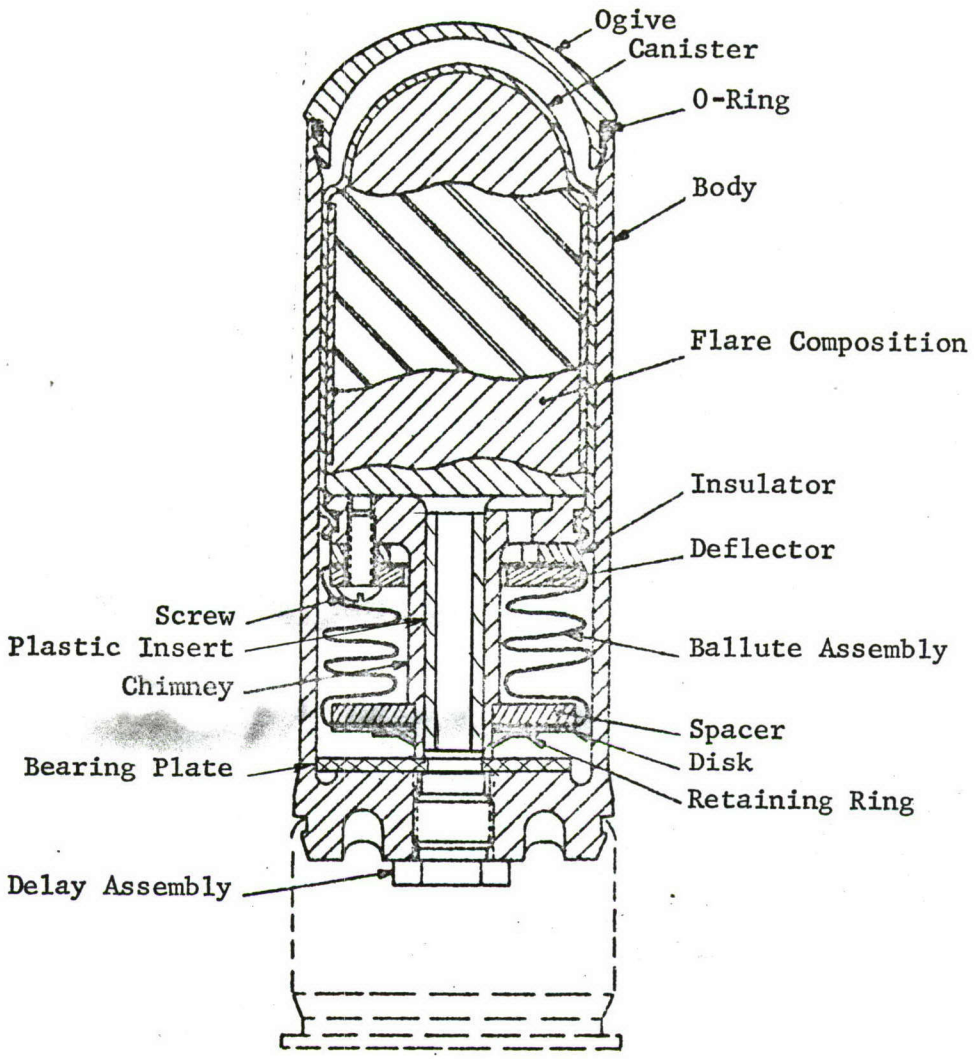

Figure 1 - 40mm Floating Flare Cross Section

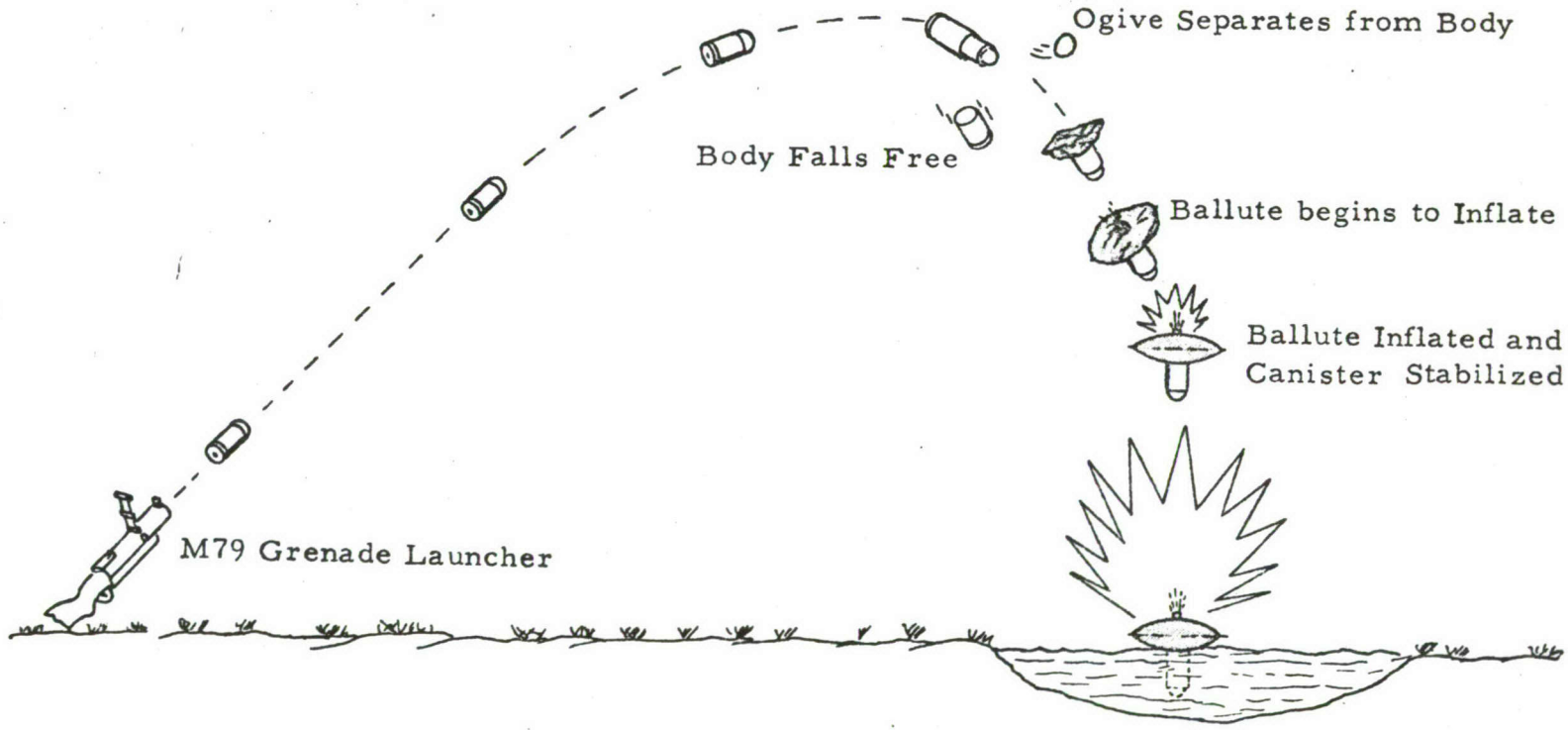

Figure 2 - 40 mm Floating Flare Sequence of Operation

CONCLUSIONS

The program objectives were achieved.

The green flare composition was sufficiently improved that this flare was visible and recognizable to a range in excess of 3000 meters for approximately 90 seconds, as were the red and yellow flares. The 90-second burn time was achieved with all colors after a modification of the red composition that increased its burn by about 10 seconds.

Reliability (all colors) was improved by increasing the quantity of first-fire (ignition) mix from 2.25 grams to 3.00, by reducing the amount of teflon in the ignition mix by 75%, and by incorporating a 4-gram intermediate mix composed of 50% ignition mix and 50% flare mix. During the final test series of 53 cartridges, there were no failures attributable to this segment of the ignition train. The two failures that occurred were attributed to failures of the pyrotechnic delay.

Additional improvements in performance and reliability were achieved by changing to a full-length plastic chimney insert. This insert eliminated slag accumulation in the chimney during burning, thereby providing smoother burning (a more uniform flame) and preventing overpressurization of the ballute, which formerly had caused ruptures and premature sinking. As a further improvement, the break strength of the thread used to stitch the ballute was increased from 1.2 pounds to 3 pounds.

More than 400 units were tested during this program. These included green - flare-composition laboratory static tests, night visibility tests, and development and qualification tests. Outdoor tests involved both static tests in water and flight tests using an M79 Grenade Launcher.

A total of 1528 cartridges were delivered to the Government. The 40 Phase I units (20 green, 10 red, and 10 yellow) were for night visibility and reliability tests, the 300 Phase II units (100 of each color) were for engineering design and safety evaluation testing, and the 1188 Phase III units (396 of each color) were for field evaluation by user troops.

HARDWARE DESIGN

1. GENERAL

The changes made to the design of the hardware during this contract effort are discussed in detail in the subsequent paragraphs.

2. BODY

The body called for in the data package and used previously on the Floating Flare round is made per Drawing 9245765. This body is not considered the standard now due to upgrading of the manufacturing tooling. The body's reduced barrel O.D. is now formed during or immediately after the basic impact extrusion operation. Formerly this reduced barrel diameter was made by a secondary machining operation. The only dimensional change in the new body is the taper angle between the forward land and barrel. This surface is now a blend versus the 30 degree angle used on the old design. With agreement of the LWL project officer, the purchase order for the bodies was amended to reflect the new standard configuration and an alteration notice (AN) was written against the assembly drawing, 040091000, allowing the optional use of alternate Picatinny Arsenal bodies 9243900 or 9255778.

3. BALLUTE

The vendor that was punching out the ballute pieces reported difficulty in preventing tearing between the I.D. and the three screw holes. From a review of the design, it appeared that the I.D. on the -2 and -3 components could be reduced from .720 + .030 inches to .65 - .05 inches. This would increase the material web between the I.D. and the three screw holes from a minimum of .025 inches to a minimum of .07 inches. In addition, the three .12 R cutouts in the I.D. didn't appear to offer any advantage to the design. Therefore, the I.D. was redimensioned and the .12 R cutout deleted on the drawing.

Because of random failures in the ballute stitched seam resulting in premature sinking, the thread size was changed from 70/2 per V-T-276 Type IA2 to 30/3 per V-T-276, Type IA1. In addition, the stitching per inch was reduced from a minimum of 25 to 15 to 20 because the closer stitched seam damaged the ballute material.

4. OGIVE

After several discussions with previous program officials and the ogive vendor, it was concluded that the ogives supplied on previous programs were made by blending 0 percent and 40 percent glass filled Lexan. The drawing calls for a 10 percent glass content in the Lexan. It was noted on the previous programs that there was a large variation in the rigidity of the ogives. This variation causes problems in the retention of the ogive in the gun barrel and subsequent ejection at delay burnout. The vendor stated that the reason for the blending of 0 percent material with 40 percent material was the fact that it was cheaper for small orders and the lead time from the material supplier for preblended material was excessive. The material supplier was contacted and asked about the advisability of a molder blending glass filled Lexan with unfilled Lexan. He said it would not work because different surface coatings are used on filled and unfilled materials. These coatings prevent proper mixing of the materials in a mold. Another problem was the ogive drawing 040055013 called for green colored Lexan by the designation MVCL 6167. The proper callout for natural colored 10 percent glass filled Lexan is 500-131.

5. DELAY

In an attempt to use as many standard components as possible in the 40MM Flare the Picatinny 40MM delay was evaluated. This delay proved highly successful and was used throughout the program. An AN was submitted on the top assembly drawing number 040091000 to allow the use of the Picatinny Arsenal delay 9243885.

Only one problem was encountered with the delays on this program and that was traced to a manufacturing technique. These delays failed to ignite the flare mix first fire. X-ray examination showed a thin layer of delay output charge between the two pressed increments. Apparently the press ram was inadvertantly depositing some of the output mix from the previous delay onto the top of the first increment of the next delay. Twenty new delays were made with the operator wiping the ram clean after pressing each delay. Tests of these delays showed the problem was corrected by this new procedure.

6. CHIMNEY

Probably the most significant improvement in performance of the hardware was made by the simplest design change. Two modes of ballute failures

were observed. The most common failure was caused by slow inflation of the ballute immediately after ejection from the body. The aerodynamic forces caused the relaxed ballute to curl around the orifice of the chimney and thereby allowing the hot flame of the flare to burn a hole in the top of the ballute. The other mode of failure was simply an overpressure of the ballute stitching. All the colored flares experienced pressure increases during the early phases of burning due to slag accumulating in the chimney. The problem was especially severe with the green units and often resulted in failure of the ballutes and subsequent sinking.

In an effort to determine the reason for the slag accumulation in the chimney, units were made and flight tested with the plastic insert in the chimney extended the full length of the chimney. It was expected that the slagging would get worse due to a theory that the char of the insert acted as a catalyst for the solid components of the exhaust gases. However, the opposite occurred. The extended insert eliminated the slag accumulation and caused the ballutes to inflate faster. The char of the insert apparently prevented the char from bonding to the wall of the chimney. This change was incorporated on the Phase II and Phase III delivery rounds.

FLARE COMPOSITIONS

1. GENERAL

The flare charge design consists of an ignition starter mix, an intermediate mix and the main flare charge, all pressed simultaneously in the listed order.

The charge is a single end burner 1.29 inches in diameter and 2.19 inches in length. The following table shows a comparison between the various colored flares.

	Red	Yellow	Green
Ignition Composition Weight (gm)	3	3	3
Intermediate Charge Weight (gm)	4	4	4
Flare Mix Weight (gm)	65	56	65
Burning Surface Area (Sq. In.)	1.30	1.30	1.30
Pressed Density (gm/cc)	1.80	1.57	1.80
Average Burn Time (Sec)	88	100	88
Average Burn Rate (In/Sec)	.025	.022	.025
Press Pressure (lbs/sq. in.)	10,000-15,000	5000	5000

The three charge components were developed through an extensive series of tests listed in the Appendixes and discussed in Section IV. Details of the chosen elements of the flare charges are discussed in the following paragraphs. Note that the intermediate charge was not used in the previous feasibility program and the yellow flare mix was not changed during this program.

2. IGNITION COMPOSITION

The Boron Potassium Nitrate ignition mixture gave generally excellent results throughout the duration of the program. However, the initial weight of 1.0 gram used on the first units was increased to 3 grams early in the program to improve the ejection of the ogive and to decrease the inflation time of the ballute. Late in the program reproducible ignition of the ignition charge became a problem and the teflon binder was reduced to aid this problem. The two compositions are given in the following table.

Components	Percent by Weight Old	New
Boron	19.2	22.6
Polytetrafluoroethylene	18.2	4.6
Potassium Nitrate	57.6	67.8
Lupersol DDM	.05	.05
Resin Polyester	4.95	4.95

3. INTERMEDIATE CHARGE

Because some ignition transfer failures between the ignition composition and the flare mix occurred in the earlier feasibility program, an intermediate charge was used during this program. The intermediate mixture consisted of a blend of 50 percent by weight ignition charge and 50 percent by weight flare mix. Initially only two grams of mix were used, however during this program this was increased to three grams then to four grams as a result of random ignition transfer and ballute inflation problems

4. FLARE MIX

The primary technical objective was to improve the color quality of the green flares. The baseline formulation, which served as the performance standard, was developed late in the previous feasibility program. Initially twenty six additives were tried, however all of the additives reduced the flare burn time considerably below the 90 second requirement or caused excessive chuffing or were too high in flame temperature. Another problem which occurred with some of the additives was incompatibility with other mix ingredients. In fact the additive that gave the best color improvement, chromic chloride, sometimes reacted with the magnesium during mixing and pressing. After the additives failed to produce the desired results of increasing both intensity and color quality, the baseline formulation was optimized. This optimization resulted from a decrease in the barium nitrate by 10 percent, a removal of the ammonium chloride, and a 5 percent increase in both the ammonium perchlorate and binder and a 10 percent increase in the magnesium content. Both the baseline (old) formulation and the new formulation are given in the following table:

Components	Percent by Weight Old	New
Barium Nitrate	35	25
Ammonium Perchlorate (Class 7)	20	25
Cellulose Acetate	12.5	15
Triacetin	12.5	15
Magnesium	10 (22μ)	20 (350μ)
Ammonium Chloride	10	--

The red flare composition carried over from the previous program burned 15 seconds short of the requirements. Therefore, a modification was made to the formulation which brought the time up to the required 90 seconds. The ammonium perchlorate content was reduced 5 percent and the magnesium content was increased 5 percent. In addition, the magnesium particle size was increased from 22 microns to 350 microns. Both the old and the new formulations are listed below for comparison.

Components	Percent by Weight Old	New
Strontium Nitrate	40	40
Ammonium Perchlorate (Class 3)	30	25
Magnesium	5(22μ)	10(350μ)
Cellulose Acetate	12.5	12.5
Triacetin	12.5	12.5

The use of the new formulation initiated in Phase II of this program and performed satisfactorily throughout the balance of the program.

No changes were made to the yellow flare mix during this program. For reference, the yellow flare mix formulation is as follows:

Components	Percent by Weight
Sodium Nitrate (Class 2)	45
Ammonium Perchlorate (Class 3)	15
Magnesium (22μ)	15
Cellulose Acetate	12.5
Triacetin	12.5

This formulation performed satisfactorily throughout the program.

TEST RESULTS

1. BASELINE TESTS

To check out the green baseline composition and the intermediate igniter mix between the ignition charge and the main charge, two static tests were conducted. The test results shown in Appendix A verified the results reported in the previous feasibility program.

2. GREEN FLARE ADDITIVE TESTS

The color additives for the green flare were investigated in three separate series. The first series screened all candidate additives by simply adding two additives to the base formulation and replacing the binder. The second test series screened the best additives from series 1 by replacing one component of the basic formulation with the additive. Several additives and components were evaluated in test series 3 by multiple substitution into the basic formulation. Evaluation was carried out by static daytime tests, static night tests for range determination and daytime flight tests.

a. Test Series 1 - Additives Screening

(1) Objective

The objective of this series was to screen additives which were incorporated in the basic formulation to determine the effect on color quality.

(2) Test Method

The additives were incorporated into the basic formulation, replacing binder - 10 percent additive for 10 percent binder. Twenty-six additives, listed in Table I, were tested. Color and burn time were recorded. The most promising additives were then tested in the basic formulation by adding 10 percent to the total formulation. All candles were tested in water without a ballute. The basic formulation is as follows:

TABLE I - ADDITIVES

Cupric Nitrate	Nickel Nitrate
Cupric Chromate	Nickel
Cuprous Chloride	Nickel Chloride
Cupric Acetate	Titanium
Cuprous Oxide	Zinc
Copper	Zinc Chloride
Chromium	Borium Chromate
Chromic Chloride	Boron
Ammonium Dichromate	Zirconium
Chromic Acetate	Picric Acid
Boric Acid	Potassium Permanganate
Tetrachloro-P-Benzaquinone	Tin
Nickel Acetate	Bronze

Component	Percent by Weight
Barium Nitrate	35.0
Ammonium Perchlorate 400 Micron	20.0
Ammonium Chloride	10.0
Magnesium, Mesh $\frac{200}{325}$	10.0
Cellulose Acetate	12.5
Triacetin	12.5

(3) Results

From this series, the following compounds were selected for further investigation in test series 2:

Chromic Chloride, Chromic Acetate, Chromium Metal, Ammonium Dichromate, Titanium, Zirconium Nickel, Nickel Acetate and Nickel Chloride.

A shoot off of the first four additives which were the most effective was conducted. The most effective additive was chromic chloride. However, the effect was not as great as expected. All raw date is shown in Appendix B.

(4) General Observations

This series indicates some color improvement can be obtained with additives. Generally, the additives which improve color quality also increase burn rate. Chromic chloride, when damp, reacts with magnesium; therefore, the magnesium should be coated (chromalized) to prevent this reaction. Nickel nitrate was found to be incompatible in the basic formulation.

b. Test Series 2 - Additives Substituted for One Component

(1) Objective

The objective was to further investigate the color improvement properties of the additives selected in test series 1.

(2) Test Method

The additive replaced one component, totally or partially, that most closely related to the additive; i.e., chromic chloride replaced ammonium chloride, chromium replacing magnesium, etc. The effect of each additive on color and burn time was compared to the control baseline formulation.

(3) Results

The results of test series 2 indicated that some color improvement may be obtained from certain additives. The best additives are listed as follows:

Chromic Chloride
Chromic Acetate
Chrome Metal

Intensity of the flare improved color to some extent, at the expense of shorter burn time.

Removal of the phenolic liner insulator tended to improve the color by reducing the amount of yellow seen in the plume with approximately 10 to 15 percent loss of burn time when tested in water. Raw data on this test series are shown in Appendix C.

c. 3500-Meter Night Visibility Tests

(1) Objective

The two major objectives of this test group were to determine if chromic chloride additive gives a more recognizable color than the control baseline formulation, and to determine if a more intense flare is more recognizable than the basic formulation.

(2) Test Method

Each test formulation was compared directly to the basic formulation. Each unit was tested without a ballute in water. The observation area was 3500 meters distant and 300 meters above the test sight. Weather was clear with a slight haze; visibility was greater than 10 miles.

(3) Results

Thirty-five hundred (3500) meter night visibility tests showed chromic chloride additive to improve the color when compared to the control. A deep rich "stop light" green was observed. The intensity was less than that of the control formulation, and neither one was really adequate.

The more intense burning formulations such as the polyvinyl chlorides were definitely recognizable as green. The color quality was about equal to the control units, but more intense. Boric acid additive improved the color to some extent, while reducing burn rate significantly. However, color improvement from boric acid was not as great as that from chromic chloride.

These intense formulations were used for intensity only. They are not suitable for the 40MM floating flare because of high flame temperatures, excessive slagging properties and drastic reductions of burn time. The data from the night visibility test are presented in Appendix D.

d. Test Series 3 - Multiple Substitution

(1) Objective

The objective of this series was to determine the effects multiple substitution of components and additives on the basic formulation's color quality and burn time.

(2) Test Method

Additives including boron, chromic chloride, polyvinyl chloride, potassium perchlorate, and teflon were substituted for various ingredients in the basic formulations. In addition, the granulation size of both the magnesium and ammonium perchlorate was varied and the effects noted. The burn time was recorded by a stop watch and the intensity by a photocell.

(3) Results

The primary results of this test series is shown on the graphs of Figure 3 through 6 and the raw test data is presented in Appendix E. Figure 3 is a plot showing the effect of magnesium and ammonium perchlorate particle sizes on intensity. The optimum particle size for ammonium perchlorate is 400 microns, while the optimum size for magnesium appears to be above 400 microns. This is one reason why 400 micron ammonium perchlorate and 350 microns magnesium is being used on the new green formulation.

Figure 4 shows the effect of magnesium percent on the intensity measurement. The family of curves was generated by substituting magnesium for various components in the basic formulation. Note that light intensity is very sensitive to the magnesium content and that the substitution of granulation 16 (22 microns) magnesium for ammonium chloride gives the greatest intensity.

The above is the reason why ammonium chloride was dropped from the formulation in favor of more magnesium.

Granulation 16 magnesium had to be changed to granulation 18 in order to maintain the proper burn time. This will be discussed later in the report.

The effect on intensity and burn time of varying the amount of barium nitrate is shown in Figure 5. The effect is not as great as the variations in magnesium content.

Figure 6 shows the influence of magnesium on burn time. Note that a two percent increase in magnesium reduces the burn time approximately ten seconds. Another significant fact obtained from Figure 6 is that approximately a 30-second burn time increase was obtained by using 350 micron size magnesium instead of the 22 micron size of the control formulation. Because of the short duration problem mentioned above, 350 micron magnesium was finally selected.

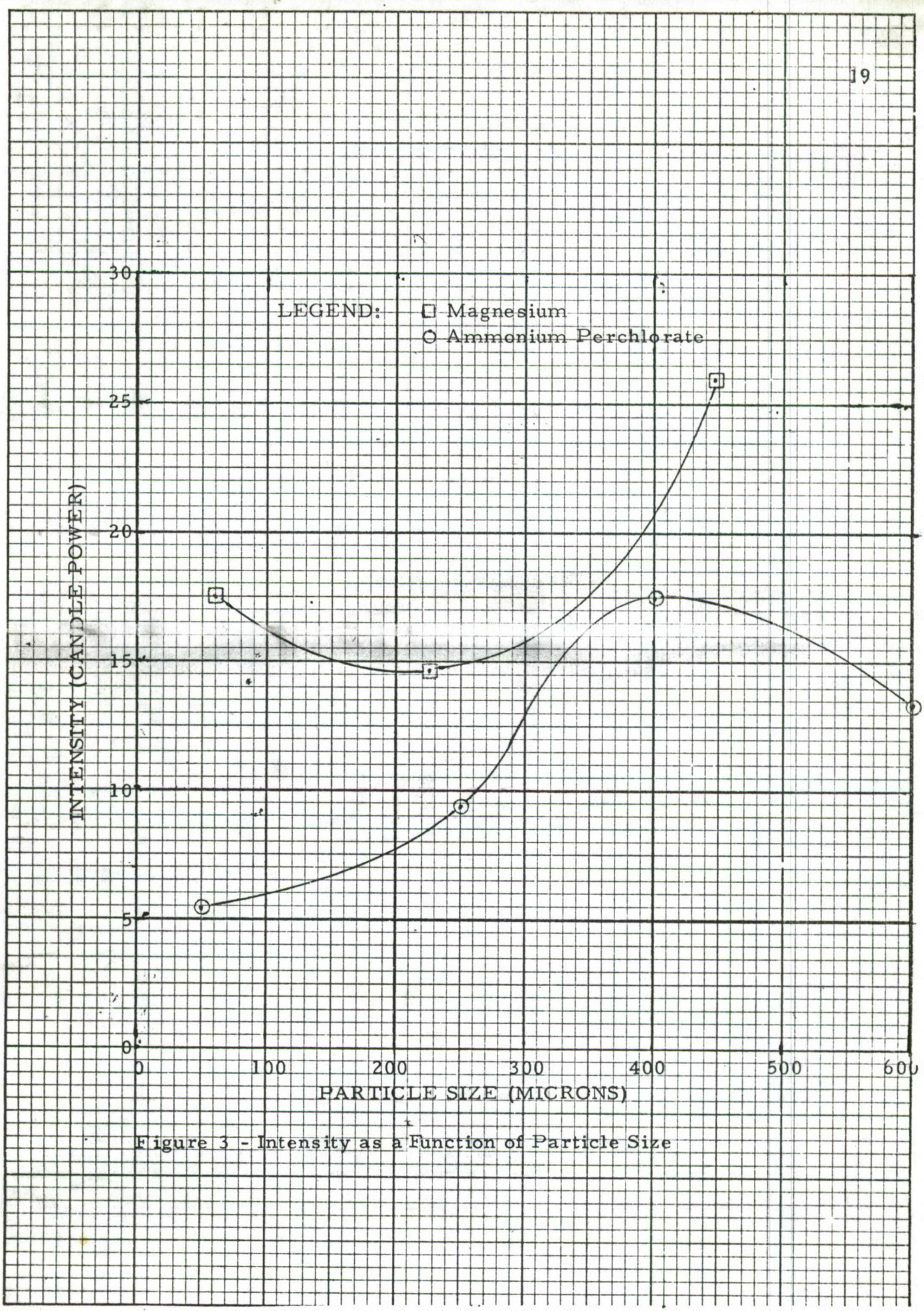

Figure 3 - Intensity as a Function of Particle Size

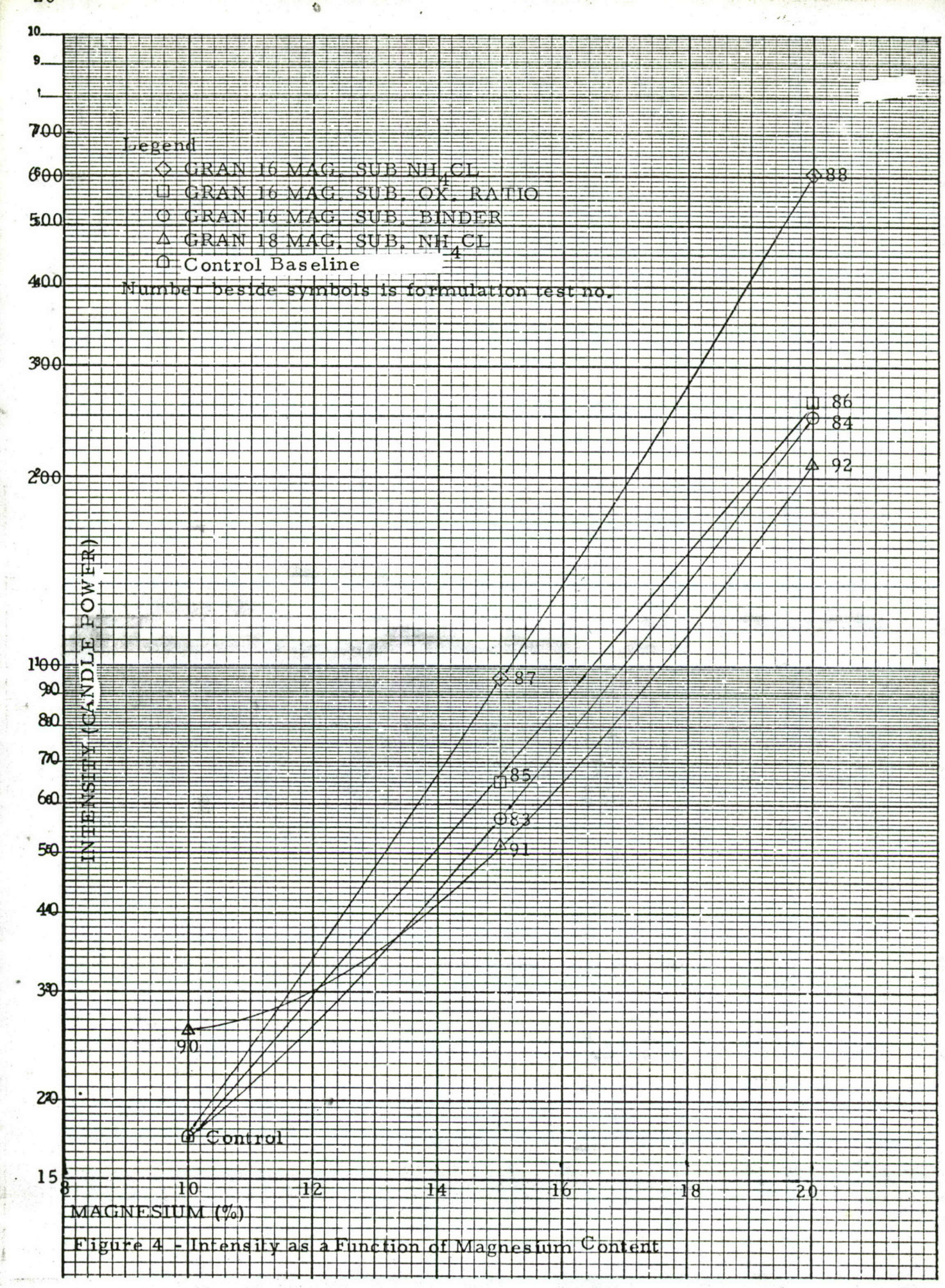

Figure 4 - Intensity as a Function of Magnesium Content

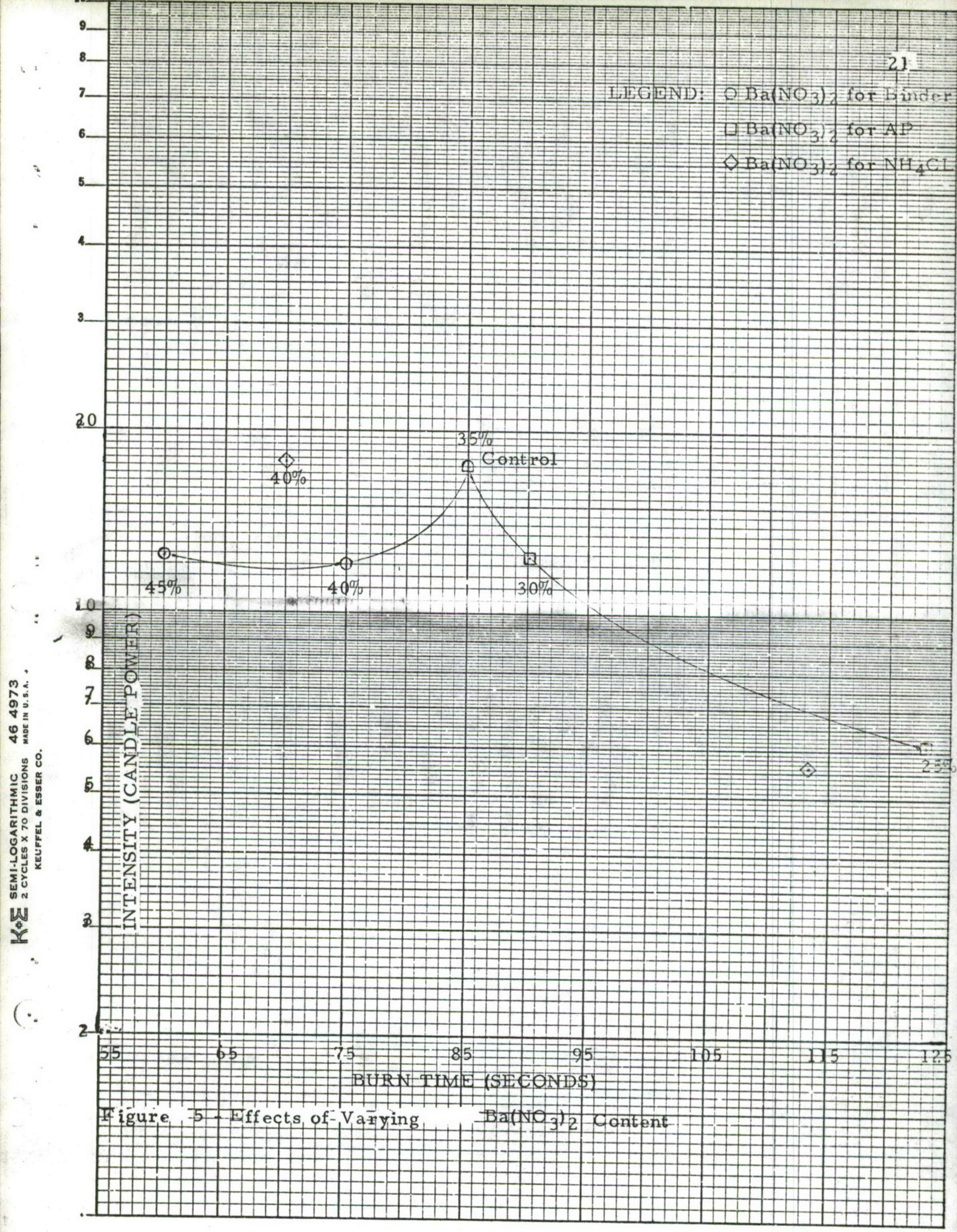

Figure 5 - Effects of Varying $Ba(NO_3)_2$ Content

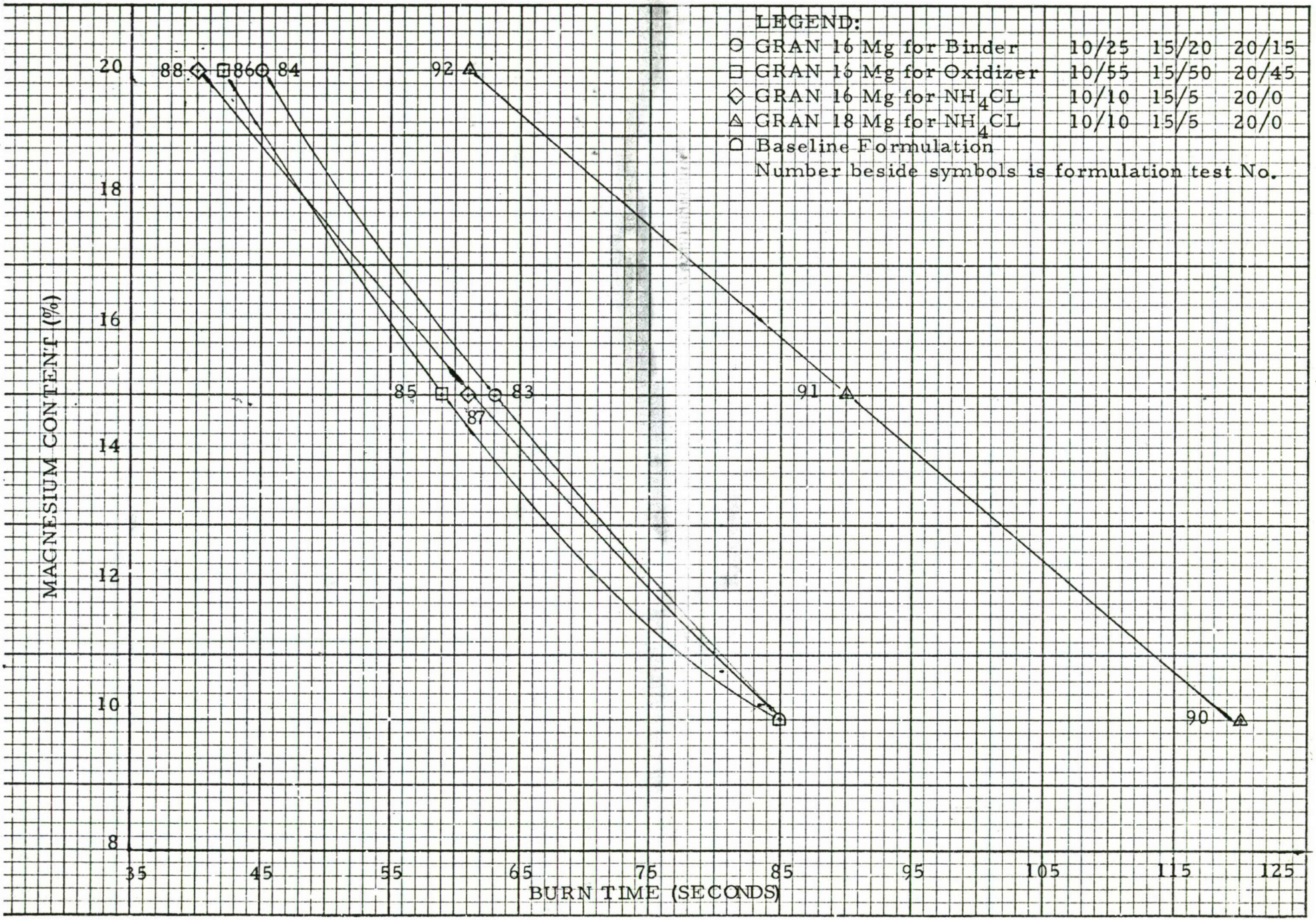

Figure 6 - Burn Time as a Function of Magnesium Content

Pressing pressure was evaluated in test series 119 through 122. By increasing the quantity of mix from 60 grams to 70 grams while maintaining the same charge volume, the burn time increased approximately 5 to 7 seconds. Therefore, the compaction pressure is not considered critical.

The use of a chrome plated chimney to prevent iron off of the chimney from entering the gas stream was evaluated in Test 149. The advantage of the plating was not significant.

In summary, the formulation that gave the best combination of intensity and burn time uses less barium nitrate, more ammonium perchlorate, magnesium, and binder than the baseline mix. This formulation also has no ammonium chloride coolant. Both the baseline formulation and the new formulation are listed below for comparison.

	Percent by Weight	
	Baseline	New
Barium Nitrate	35.0	25.0
Ammonium Perchlorate (400 μ)	20.0	25.0
Magnesium	10.0 (22 μ)	20.0 (350 μ)
Cellulose Acetate	12.5	15.0
Triacetin	12.5	15.0
Ammonium Chloride	10.0	0

3. PHASE I DEVELOPMENT AND QUALIFICATION TESTS

The projectile tumbling problem, which had occurred randomly in previous flight tests, was solved by switching to a relatively new gun barrel. As shown by the data sheets in Appendix F, tumbling did not occur after the newer gun barrel was used.

Sinking rarely occurred after increased stitching on the ballute was used. Thereafter, sinking usually could be attributed to a ballute that had been pinched or cut during assembly.

The next test series, 209 through 214, showed an ignition problem in transferring from the delay to the first fire layer. This was the first tests of the second lot of delays and therefore the delays were suspect. In fact, in test 211 the unit was recovered and the delay had expelled a portion of the tungsten composition into the projectile body. X-ray examination of the delays showed the presence of delay first fire between the two increments of tungsten composition. The delay vendor was contacted to correct the problem.

In order to circumvent the delay problem and continue testing, five green units were fabricated with one gram of FFG black powder in the first fire and five standard green units were fabricated at the same time as control rounds. However, the black powder did not aid the first fire ignition and ogive ejection because of the delay problem. Two out of the five rounds containing the black powder were duds. The test results and data are shown in Appendix F. Serial numbered rounds 216, 218, 220, 222 and 224 had the black powder additive in the first fire. The other five units, 215, 217, 219, 221, and 223 were built like the previous units without any black powder in the first fire. One dud was experienced from this group.

Ten green units were fabricated to evaluate the new, carefully made delays. The flare ingredients were dried overnight at 150°F. The ten rounds were assemblied and flight tested. All ten units functioned satisfactorily proving the new delay pressing procedure. The data on the flight tests of these ten rounds are shown in Appendix F (S/N 225 through 234).

Ten additional green units were fabricated and tested to checkout a new batch of 120 delays. These units (S/N 235 through S/N 244) also were used to verify the assembly technique of a new technician.

As can be seen from the data in Appendix F, the delays functioned normally with time ranging from 5 to 5.8 seconds. However, the technician inadvertantly left out the plastic orifice in the chimney. The first four units were fired into water and tumbling was observed after flare ejection. Normally when this occurs the ballute has a hole or a ripped seam. To determine the specific nature of the failure, unit 239 was fired onto land and recovered. The stitched seam on the ballute's outer circumference was broken. The remaining five units were disassembled and rebuilt with the plastic orifice. All of these five rounds functioned normally. Although the reason why the lack of an orifice causes ballute seam damage was not fully understood the effect was extreme.

Green units 245 to 254 were fabricated and tested to check out a new batch of first fire and to evaluate the effect of a cut ballute on flotation performance. From the data shown in Appendix F, only 6 out of 10 functioned satisfactory. However the units with the cut ballutes functioned adequately. The ejection of the flare from the projectile body was sluggish which is a problem associated with the combined effects of delay venting, first fire combustion, chimney orifice insert and ogive joint. In order to aid in determining the cause of the failure, five units from the same batch were disassembled and inspected. These units, 255 to 259 were found to have been assembled correctly and were reassembled with different ogives to see if ogive ejection was the source of the problem. Ogives on units 255 and 256 were replaced with white ogives, a design which was used on the previous program. 257 and 258 were repacked with new ogives of the current configuration. 259 was repacked with the original ogive. As shown in the appendix only one unit failed to function properly. Unit 257 which had been repacked with a new ogive sank. Even though this test series showed that the ogive could be a contributor in the sinking problem it is one of the most difficult elements in the chain to modify. Lack of quantative data on slot configuration, glass content and lip design make the ogive release force the most difficult to evaluate analytically. Therefore, it was decided that a review of the first fire should be made. Previous batches of first fire were made with the ingredients unscreened. The first fire batch for units 245 to 259 was made by screening the ingredients in an attempt to get more uniform mixture. Ten green units were made by the earlier process and flight tested. As shown by the data sheets for units 260 to 269 all units functioned normally. This successful test series tended to prove that the method of first fire processing was the cause of the previous sinking problems.

Units 270 to 301 were fabricated and tested for the qualification of the green flare batches. The test results were not perfect but satisfactory.

A special static test series was conducted with green flare units 302 to 307. Zinc, cadium and nickel plated chimneys were used to see if color quality would be affected. No effect was noted.

Because of random ballute seam failures, the thread size was increased from a number 50 to a number 40 for the subsequent units. Units 308 to 331 were qualification tests for all three colors. Because two out of five red units on the last batch failed, the batch was rejected. It was observed that the red units tended to flame out in flight tests. To observe this phenomenon more closely, two units from the same defective batch were burned in the laboratory. Units 332 and 333 functioned normally with the flame standing off from the chimney. However, because of the poor flight tests, the batch was rejected. The new batch was tested with units 334 to 337. Since only one unit sank, the batch was accepted. It was speculated that a hole burned in the ballute may have caused the unstable descent and sinking of that one unit.

Two units, 338 and 339, were made in the laboratory to determine if a longer-burning-duration flare could be achieved with a modified red formulation. The magnesium particle size and quantity was increased from 22 microns and 5 percent to 350 microns and 10 percent. The ammonium perchlorate content was reduced from 30 percent to 25 percent. The last unit burned 91 seconds, which is a substantial improvement over what was previously achieved. Both the old and the new formulation are listed below for comparison.

	Percent by Weight	
Components	Old	New
Strontium Nitrate	40	40
Ammonium Perchlorate (50μ)	30	25
Magnesium	5 (22μ)	10 (350μ)
Cellulose Acetate	12.5	12.5
Triacetin	12.5	12.5

4. PHASE II DEVELOPMENT AND QUALIFICATION TESTS

Green units 340 to 350 were fabricated and tested for Phase II qualification. However, as shown in Appendix G, four units had trouble in ejecting the slag buildup in the chimney. During the course of the subsequent investigation an attempt was made to isolate the source of the slag buildup. One theory was the char from the plastic chimney insert acted as a catalyst causing the solid exhaust products to condense out on the inside of the chimney. Therefore, to check out this theory, three

units (S/N 351, 352 and 353) were static tested with the plastic insert the full length of the chimney. This was expected to cause an increase in the slag accumulation. However, the opposite occurred, there was no slagging of any kind and all three units burned smoothly. Flight tests conducted on green units numbers 354 to 363 also verified that the longer insert eliminates the slag buildup in the chimney. One reason that the longer insert may have prevented slagging is the hot char layer that the insert creates prevents condensation of the solid exhaust products. In addition, the char surface may prevent a strong bond of the solid products to the chimney.

Units 364 to 373 were flight tests for red color qualification. All units performed very satisfactory. All ten red units also employed the longer insert in the chimney and the new formulation.

The qualification units for the yellow (374 to 381) also performed quite satisfactory with the full length plastic chimney insert. Unit 382 was an extra red unit that was tested with the yellow rounds and it too functioned normally.

5. PHASE III DEVELOPMENT AND QUALIFICATION TESTS

Because of doubts about the exact specification for the ammonium perchlorate used in two of the colors, a sieve analysis was performed on three samples. This granulation analysis was conducted in accordance with method 201.1 of MIL-STD-1234 and the results are given below.

		% Passing thru Sieve Sample			% Retained on Sieve Sample		
U.S. Sieve	Microns	1	2	3	1	2	3
100	149	100	100	100	0	0	0
140	105	96	95	95	4	5	5
200	74	74	72	70	26	28	30
325	44	69	71	69	31	29	31

From the above analysis it appears that the ammonium perchlorate sometimes referred to as 50 micron size should be specified as Grade B, class 3 of MIL-A-192.

Phase III qualification started with eighteen green rounds (383 to 400), however as shown by the test data in Appendix H only eleven functioned satisfactory. Seven rounds failed to eject at delay burnout and two of these rounds vented through the delay causing the rounds to go propulsive. From past experience it was immediately concluded that these failures were caused by the slowness of the ignition mix. This problem had occurred before and was solved by very careful control of the manufacturing procedure. However, because of the reoccurring ignition problem it was decided to reduce the binder content. The ignition charge

has two different binders, lupersol DDM/polyester and teflon. In addition, the binder quantity is quite high, over twenty three percent. Therefore, five rounds (401 to 405) were made and tested using an ignition mix with twenty five percent less teflon. Two rounds functioned satisfactory, one ejected and burned under water and two rounds went propulsive. Units 406 to 408 were fabricated and tested to determine the effect of no teflon in the ignition mix. All three of these rounds performed normally except that all three sank immediately after burnout. It was concluded that the greater pressurization rate of the ignition mix without teflon must have ruptured the ballutes. If this was the case then premature sinking could occur. Therefore, five rounds (409 to 413) were manufactured with seventy five percent less teflon in the ignition charge and test fired. As shown in Appendix H all but one round experienced good ejection and flotation. One unit had a delay failure which could not be assigned as an ignition failure. To confirm the success of the above tests and to complete qualification of the green flares, Units 414 to 426 were fabricated and tested with seventy five percent less teflon in the ignition mix. All but one round performed normally. The one failure was believed to have been caused by a delay failure since no spit was seen from the delay at the proper ejection time.

Units 427 to 446 were flight tests for red color qualification. All twenty units performed very satisfactory.

Units 447 to 461 were flight tests for yellow color qualification. All of these rounds functioned completely as shown in Appendix H.

APPENDIX A

BASELINE GREEN FLARE DATA

APPENDIX A

40MM FLOATING FLARE BASELINE GREEN FLARE DATA

DATA SHEET

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Ballute Capability	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		$B_a(NO_3)_2$	Gran. 16	CA 50 TA 50	AP	NH_4CL										
A	4/72	35	10	25	20	10		60	1/2	77		good	W	-	S	1 gram first-fire 2 grams 50% first-fire 50% Mix
																base line verification
B	4/72	35	10	25	20	10		60	1/2	79		good	W	-	S	o.k.

APPENDIX B

TEST SERIES 1 - GREEN FLARE COMPOSITION DATA

APPENDIX B - 40MM FLOATING FLARE DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition: Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Ba	200/325	CA/TA	AP/400	NH_3/HCL			1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
1	5/72	35	10	15	20	10	10	60	1/2	55		Poor	W		S	Blue-white - no green.
							Cupric Nitrate									-
2	5/72						10		1/2	56		Poor	W		S	Blue-white - no green.
							Cupric Carbonate									
3	5/72						10		1/2	39		Poor	W		S	Blue-white - no green.
							Cuprous Chloride									
4	5/72						10		1/2	55		Poor	W		S	Blue-white - very slight tint of green.
							Cupric Acetate									

40MM FLOATING FLARE DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400	NH_3 HCL			1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
5	5/72						10		1/2	42		Poor	W		S	Blue-white - no green.
							Cuprous Oxide									
6	5/72						10		1/2	52		Poor	W		S	Blue-white - very slight tint of green.
							Copper Metal									
7	5/72						10	60	1/2	51		Good	W		S	Intense green, even color in plume.
							Chrom Metal									
8	5/72						10		1/2	32		Good	W		S	Intense green.
							Chromic Chloride									

40MM FLOATING FLARE

DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									1 gram 100% first fire 2 grams 50% first fire 50% flare mix
		Ba	200/325	CA/TA	AP/400	NH_3/HCL										
9	5/72						10		1/2	60		Good	W		S	Intense green.
							Ammonium Dichromate									
10	5/72						10		1/2	60		Good	W		S	Intense green.
							Chromic Acetate									
11	5/72						10			-			W		S	Did not burn.
							Boric Acid									
12	5/72						10			84		Fair	W		S	Color equal to control.
							Tetrachloro-P-Benzoquinone									

40MM FLOATING FLARE DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition: Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Ba	200/325	CA/TA	AP/400	NH_3/HCL			1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
13	5/72						10		1/2	61		Fair/Good	W		S	Slightly better than control formulation.
							Nickel Acetate									
14	5/72						10		1/2	-			W		S	Nickel nitrate is incompatible with these components.
							Nickel Nitrate									
15	5/72						10		1/2	57		Fair/Good	W		S	Slightly better than control formulation.
							Nickel Chloride									
16	5/72						10		1/2	51		Good	W		S	Better than standard - not as good as Chrom and Chrom Salts.
							Titanium									

40MM FLOATING FLARE DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400	NH_3 HCL			1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
17	5/72						10		1/2	67		Good	W		S	Better than standard - not as good as Chrom & Chrom Salts.
							Zinc Metal									
18	5/72						10		1/2	61		Good	W		S	Better than standard - not as good as Chrom & Chrom Salts.
							Zinc Chloride									
19	5/72						10		1/2	60		Fair/Good	W		S	Slightly better than control.
							Barium Chromate									
20	5/72						10	60	1/2	27		Fair/Good	W		S	Green-white - Very hot.
							Boron									

40MM FLOATING FLARE DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400	NH_3 HCL			1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
The following 6 tests were to determine best color improvement by additive.																
21	5/72						10	60	1/2	-		Good			S	Good color, better than standard, equal to color of chrom acetate and ammonium dichromate.
							Chrom									
22	5/72						10	60	1/2	-		Good to Excellent	W		S	Best color of shoot off. Deepest rich green of all 6 tests.
							Chromic Chloride									
23	5/72						10	60	1/2	-		Good	W		S	Good color, better than standard, equal to color of chrom metal and ammonium dichromate.
							Chromic Acetate									
24	5/72						10	60	1/2	-		Good	W		S	Good color, better than standard, equal to color of chrom metal and chrom acetate.
							Ammonium Dichromate									

40MM FLOATING FLARE

DATA SHEET

Test Series 1 - Additives Replacing Binder

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400	NH_3 HCL			1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
25	5/72	39	11.1	16.7	22.1	11.1	0	60	1/2	-		Good	W		S	Better than standard - color quality almost equal to chrom salts.
26	5/72	35	10	25	20	10		60	1/2	-		Fair	W		S	Standard formulation.
27	5/72	35	10	15	20	10	10	60	1/2			Good	W		S	Good color - produced the most light to date; however, a lot of white in green.
							Ziaconiom									

40MM FLOATING FLARE

DATA SHEET

Test Series 1 - Replacing all Components 10% with Additive

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	50/50	AP/400	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
27B	5-72	31.5	9	22.5	18	9	10%			40		Good	W		S	Good color. Lot of light.
							Chrom									
28	5-72						10			55		Good/Fair	W		S	Good color. Faded to green-yellow at end.
							Chromium Acetate									
29	5-72						10			62		Good	W		S	Good color. Turned yellow at times (non-homogenious). Darkest,
							Chromic Chloride									(richest) green of 27B and 32.
30	5-72						10			75		Fair/Poor	W		S	Poor yellow-green color.
							Ammonium Dichromate.									

40MM FLOATING FLARE

DATA SHEET

Test Series 1 - Replacing all Components 10% with Additive

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	50/50	AP/400	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
31	5/72						10			43		Good	W		S	Very hot, melted chimney, lot of sparks. Large amount of light.
							Zirconium									
32	5/72						10			53		Good	W		S	Good color, best toweard end of burn. Lot of sparks, hot.
							Titanium									
33	5/72						10			60		Good/Fiar	W		S	Green, some yellow. Faded toward end.
							Potassium Permangate									
34	5/72						10			60	40	Good	W		S	This improved the color some. The flame was larger and more opaque.
							Piric Acid									

40MM FLOATING FLARE

DATA SHEET

Test Series 1 - Replacing all Components 10% with Additive

Serial Number	Test Date	Percent Composition: Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Ba	200/325	50/50	AP/400	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
35	5/72	35	10	25	20	10				60	75	good/fair	W		S	Plume more transparent than 34.
36	5/72	31.5	9	22.5	18	9	10%			75		good	W		S	
							Bronze (89% CU, 8% SN, 2% ZN, .7% NI)									
37	5/72	31.5	9	22.6	18	9	10%					poor	W		S	Blue-white - slight green tint.
							Copper									
38	5/72	31.5	9	22.5	18	9	10			67		poor/fair	W		S	Yellow-green.
							Nickel									

40MM FLOATING FLARE

DATA SHEET

Test Series 1 - Replacing all Components 10% with Additive

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	50/50	AP/400	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
39	5/72	31.5	9	22.5	18	9	10			67		good	W		S	
							Tin									
40	5/72	31.5	9	22.5	18	9	10					good	W		S	Shoot off between 40 and 41 - slightly better than control.
							Tin									
41	5/72	35	10	25	10	10						good	W		S	Control formulation.

APPENDIX C

TEST SERIES 2 - GREEN FLARE COMPOSITION DATA

APPENDIX C - 40MM FLOATING FLARE

DATA SHEET

Test Series 2 - Additives Replacing Components in Baseline Formulation

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400μ	NH_3/HCL										
42	5/72	35	10	10	20	25	0	60	1/2	180		fair/poor	W		S	Replacing binder with ammonium chloride to reduce carbon content.
																Pulsating green. Green color not intense.
43	5/72	35	10	10	20	10	15	60	1/2	34		good/fair	W		S	Replacing binder with chromic chloride. Green plume - some
						Chromic		Chloride								better than control. This formulation has some incompatibles..
																Mix got hot spontaneously.
44	5/72	35	5	25	20	10	5	60	1/2	93		good/fair	W		S	Slightly better than control. Replacing mg with chromic chloride.
						Chromic		Chloride								
45	5/72	35	0	10	20	10	10	60	1/2	no burn			W		S	No burn - replacing Cr for magnesium.
						Chrom		Metal								

Test Series 2 - Additives Replacing Components in Baseline Formulation

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400	NH_3/HCL										
46	5/72	35	2	10	20	10	8	60	1/2	no burn			W		S	No burn - replacing chromium for magnesium.
							Chrom Metal									
47	5/72	35	5	25	20	10	5	60	1/2	100		fair/poor	W		S	Replacing chromium for magnesium. Poor yellow-green. Large wisky plume.
							Chrom Metal									
48	5/72	35	0	25	20	10	10	60	1/2				W		S	Replacing magnesium with zirconium. No burn.
							Zirconium									
49	5/72	35	2	25	20	10	8	60	1/2			poor	W		S	Replacing magnesium with zirconium. Fair green flame intermittent with yellow.
							Zirconium									

Test Series 2 - Additives Replacing Components in Baseline Formulation

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400μ	NH_3/HCL										
50	5/72	35	5	25	20	10	5	60	1/2	103		poor	W		S	Replacing magnesium chromic chloride.
							Chromic	Chloride								
51	5/72	35	10	25	20	9	10	60	1/2	37		good	W		S	Replacing ammonium chloride with chromic chloride. Good color. Hot.
							Chromic	Chloride								
52	5/72	35	10	25	10	10	10	60	1/2	47		good	W		S	Replacing ammonium perchlorate with chromic chloride. Very good color.
						Chromic	Chloride									
53	5/72	35	10	25	0	10	20	60	1/2				W		S	Mix heated, not pressed.
							Chromic	Chloride								

40MM FLOATING FLARE

DATA SHEET

Test Series 2 - Additives Replacing Components in Baseline Formulation

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400	NH_3/HCL										
54	5/72	35	10	25	10	10	10	60	1/2	120		poor	W		S	Replacing ammonium perchlorate with ammonium dichromate. Poor - yellow-green.
							Ammonium Dichromate									
55	5/72	35	10	25	20		10	60	1/2	48		fair	W		S	Replacing ammonium chloride with chromic acetate.
							Chromic Acetate									
56	5/72	38.9	12	15	22.2	12		60	1/2	60		good	W		S	Basic formulation with 10% of binder removed, burned with insulation.
57	5/72	38.9	12	15	22.2	12		60	1/2	50		good	W		S	Basic formulation with 10% of binder removed. Burned without insulation. The color of this unit was better at the beginning (first 15 sec.) then became equal to 56.

40MM FLOATING FLARE DATA SHEET

Test Series 2 - Additives Replacing Components in Baseline Formulation

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	CA/TA	AP/400μ	NH_3/HCL										
58	5/72	35	10	25	20	10		60	1/2				W		S	Burned with liner. Basic formulation.
59	5/72	35	10	25	20	10		60	1/2				W		S	Burned without liner. Basic formulation. Little difference could be seen between 58 and 59.
60	5/72	35	5	25	20	10	5 Titanium	60	1/2	97		poor	W		S	Replacing magnesium with titanium.
61	5/72	35	5	25	20	10	5	60	1/2	75		poor	W		S	Replacing magnesium with Boron.
62	5/72	35	5	25	20	10	5	60	1/2	75		poor	W		S	Replacing magnesium with Boron.

APPENDIX D

NIGHT VISIBILITY GREEN FLARE TEST DATA

APPENDIX D - 40MM FLOATING FLARE

DATA SHEET

3500-Meter Night Visibility Test

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test		Static or Flight Test	Configuration and/or Remarks Weather - Clear night - slight ground haze; visibility > 10 miles.
		Nitrate	Magnesium	CA/TA Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	50/50	AP 400μ	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
63	5/72	31.5	9	22.5	18	9	10	60	1/2	51		good	W		S	Color distinctly better than control darker, richer green. Intensity
							Chromic		Chloride							lower than control. Intensity not adequate for acquisition.
64	5/72	42.1	31.6 G18	12.6 PVC 4.2 TA	9.5 KCL	O_4		60	1/2	29		good	W		S	Very intense green, no question in identifying color. Color - too central but much more intense. This formulation was chosen because of its intensity. It has several disadvantages.
65	5/72	37.9	28.4 G18	11.3 PVC 3.8 TA	8.6 KCL	O_4	10 Boric Acid	60	1/2	48		good	W		S	Boric Acid. Very intense green, no question in identifying color. Not as intense as 64. Color richer than 64, not as rich as 63.
66	5/72	33.7	25.3 G18	10.1 PVC 3.4 TA	7.6 KCL	O_4	20	60	1/2	62		good	W		S	Boric Acid Intense green. No question in identifying color. Not as intense as 65. Color richer than 65. Heavy slag formed in unit.

40MM FLOATING FLARE

DATA SHEET

3500-Meter Night Visibility Test

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test		Static or Flight Test	Configuration and/or Remarks Weather - Clear night - slight ground haze; visibility > 10 miles.
		Nitrate	Magnesium	CA / TA Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200 / 325	50 / 50	AP 400μ	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
67	5/72	31.5	9	25 CA/ TA	20 AP	9	10 Chromic Chloride	60	1/2	47		good	W		S	Color distinctly better than control, richer, darker green. Not as intense as control. Intensity not adequate.
68	5/72	42.1	31.6 G18	12.6 PVC 4.2 TA	9.5 KCLO$_4$			60	1/2	26		good	W		S	Very intense green. Very easy to acquire and identify.
69	5/72	37.9	28.4 G18	11.3 PVC 3.8 TA	8.6 KCLO$_4$		10 Boric Acid	60	1/2	46		good	W		S	Very intense green, color some lighter than 68 and 67. Difficult to compare to control.
70	5/72	33.7	25.3 G18	10.1 PVC 3.4 TA	7.6 KCLO$_4$		20 Boric Acid.	60	1/2	55		good	W		S	Intense green color. Some better than 69 or 68.

40MM FLOATING FLARE

DATA SHEET

3500-Meter Night Visibility Test

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test		Static or Flight Test	Configuration and/or Remarks Weather - Clear night - slight ground haze; visibility > 10 miles.
		Nitrate	Magnesium	CA/TA Binder	Secondary Oxidizer	Coolants	Other Additives									
		Ba	200/325	50/50	AP 400μ	NH_3 HCL		60	1/2							1 gram 100% first fire 2 grams 50% first fire 50% flare mix
71	5/72	31.5	9	22.5 CA	18 AP	9	10	60	1/2	55		good/fair	W		S	Chromium. Color - white at first then fading to green-blue-white.
				TA			Chrome		Metal							More intense than control.

APPENDIX E

TEST SERIES 3 - FLARE COMPOSITION DATA

APPENDIX E - 40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition: Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
72	6/72	35	10	25	0	10	20	60	1/2	162		fair / good	W		S	The tip end of the plume was a deep green. The best to date. The
			Boron				$CrCL_3$									center was a yellow. Difficult to ignite.
73	6/72	35	15%	25%	0	5	20	60	1/2	75		fair / good	W		S	
			Boron				C_rCL_3									
74	6/72	60		PVC 40												Unit smoked. No flame.
75	6/72	66	15	15 PVC			2	60	1/2	60		good				Very interesting, bright. Color good.
							Copper									
76	6/72	50	20	16/4	10			60	1/2	45		good				Very intense, bright. Color good.
				PVC/TA	KCLO$_4$											
77	6/72	42.1	31.6	12.6/4.2	9.5	-		60	1/2	39		good	W		S	White-green plume, very intense, very hot. Most intense flare to
			G18	PVC/TA	KCLO$_4$											date. Note, G18MAG is 30/50 mesh ratio.
78	6/72	37.9	28.4	11.3/3.8 PVC/TA	8.6 KCLO$_4$		10	60	1/2	53		good	W		S	White-green plume, intense, good green in reflected light, hot. Moderate slag.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
79	6/72	33.7	25.3	3.4	7.6		20	60	1/2	71		good	W		S	White-green plume. Good green in reflected light, hot, lot of slag.
			G18	PVC/TA	KCLO$_4$											
80	6/72	35	10	25 CA	20	10		60	1/2	75		good				Equal to control formulation. Note: G16MAG is 200/325 mesh ratio.
			G16		AP											
81	6/72	35	10	25	20	10		60	1/2	87		poor		37.5		Teflon binder - poor color - yellow-white. 37.5 CP intensity.
			G16	Tef.	AP											
82	6/72	35	10	25	20	10	0			55			W	17.5	S	Control formulation.
			G16		AP											
83	6/72	35	15	20	20	10	0			63			W	57	S	G16 Mg for binder. Color = control.
			G16		AP											
84	6/72	35	20	15	20	10	0			45			W	250	S	G16 Mg for binder. Color = control.
			G16		AP											

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
85	6/72	31.8	15	25	18.1	10	0			59			W	65	S	G16 Mg for oxidizer ratio. Color control.
			G16													
86	6/72	28.6	20	25	16.3	10	0			42			W	259	S	G16 Mg for oxidizer ratio. Color control.
			G16													
87	6/72	35	15	25	20	5	0			61			W	95.5	S	G16 Mg for NH_4CL.
			G16													
88	6/72	35	20	25	20	0	0			40			W	608	S	G16 Mg for NH_4CL.
			G16													
89	6/72	35	10	25	20	10	0			93			W	14.7	S	G17 Mg for G16 Mg unit chuffed.
			G17													
90	6/72	35	10 G18	25	20	10	0			120			W	26	S	G18 Mg for M16 Mg unit chuffed.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
91	6/72	35	15	25	20	5	0			90			W	51.7	S	G18 Mg for NH_4CL. Color = control. Same slag formation.
			G18													
92	6/72	35	20	25	20		0	60	1/2	61				210		G18 Mg for NH_4CL. Color = control.
			G18													
93	6/72	30	10	25	25	10	0	60	1/2	89				12.4		400μ AP for $B_a(NO_3)_2$. Color = control.
			G16													
94	6/72	25	10	25	30	10	0	60	1/2	123				6.1		400μ for $B_a(NO_3)_2$. Color = control. Faded toward end.
			G16													
95	6/72	35	10	25	25	5	0	60	1/2	74				16		400μ for NH_4CL. Color = control. Small plume.
			G16													
96	6/72	35	10 G16	25	30	0	0	60	1/2	74				14		400μ AP for NH_4CL. Color = control intermittent flame.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
97	6/72	35	10	25	20	10	0	60	1/2	77				13.4		600μ AP for 400μ AP. Color = control. Flame went out toward
			G16													end of burn.
98	6/72	35	10	25	20	10	0	60	1/2	120				67.9		250μAP for 400μAP. Color = control. Questionable data point.
			G16													
99	6/72	35	10	25	20	10	0	60	1/2	119				10.4		250μAP for 400μAP. Color = control.
			G16													
100	6/72	35	10	25	20	10	0	60	1/2	107				8.3		250μ AP for 400 μ AP. Color = control.
			G16													
101	6/72	35	10	25	20	10	0	60	1/2	143				5.2		55μ AP for 400μ AP.
			G16													
102	6/72	30	10 G16	25	25	10	0	60	1/2	-				7.4		250μ AP for $B_a(NO_3)_2$ unit chuffed itself out.

40MM FLOATING FLARE DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
103	6/72	25	10	25	30	10	0	60	1/2	119				6.6		250μ AP for $B_a(NO_3)_2$. Slight chuffing.
			G16													
104	6/72	35	10	20	25	10	0	60	1/2	81				8.6		250μ AP for binder. Color = control.
			G16													
105	6/72	35	10	15	30	10	0	60	1/2	66				19		250μ AP for NH_4CL. Color = control.
			G16													
106	6/72	30	10	25	20	15	0	60	1/2	113				5.6		$B_a(NO_3)_2$ for NH_4CL. Color - control.
			G16													
107	6/72	40	10	25	20	5	0	60	1/2	69				17.8		$B_a(NO_3)_2$ for NH_4CL. Color = control.
108	6/72	45	10	25	20	0	0	60	1/2	51				60		$B_a(NO_3)_2$ for NH_4CL. Color = control.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
109	6/72	35	15 G18	25	20	5	0	60	1/2	88		good	W	49	S	G18 Mg for NH_4CL, 250μ AP for 400μ AP. Some slag.
110	6/72	35	10 G18	25	20	10	0	60	1/2	118		good	W	7.3	S	G18 Mg for G16. 250μ AP for 400μ AP.
111	6/72	35	10 G18	25	25	5	0	60	1/2	99		good	W	16.1	S	250μ AP for NH_4CL. G18 Mg for G16 Mg. Good color. Slow rise time.
112	6/72	25	10 G18	25	30	0	0	60	1/2	84		good	W	16	S	250μ AP for NH_4CL. G18 for G16. Good color. Some slag.
113	6/72	35	20 G18	25	20	0	0	60	1/2	64		good	W	150	S	G18 for NH_4CL and 250μ AP for 400μ AP. Bright - good color.
114	6/72	35	15 G18	25	10	5	0	60	1/2	82		good	W	32	S	Gran 18 Mg for NH_4CL. 600μ AP for 400μ AP.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
115	6/72	35	20	25	20	0	0	60	1/2	64		good	W	107	S	Gran 18 Mg for NH_4CL. 600μ AP for 400μ AP. Good color. Slagged up.
			G18													
116	6/72	35	10	25	20	10	0	60	1/2	129		poor	W	7.2	S	Gran 18 for Gran 16. 600μ AP for 400μ.
			G18													
117	6/72	35	10	25	20	0	10	60	1/2	41.1		poor	W	41.1	S	Chromic acetate for NH_4CL.
			G18													
118	6/72	35	10	25	20	0	10	60	1/2	71		good	W	20.75	S	Chromic chloride for NH_4CL. G18 Mg for G16.
			G18													
119	6/72	35	15	25	20	5	0	60	1/2	89		good	W	57	S	119 through 122 increasing press density. Some slag formation.
			G18													
120	6/72	35	15 G18	25	20	105	0	65	1/2	91		good	W	38	S	Some slag formation.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
					AP 400											
121	6/72	35	15 G18	25	20	5	0	70	1/2	94		good	W	39	S	Some slag formation
122	6/72	35	15 G18	25	20	5	0	70	1/2	96		good	W	28	S	Some slag formation
123	6/72	35	15 G18	25	20	5	0	60	1/2	92		good	W		S	Tested with ballute, fair inflation, slagged up
124	6/72	35	15 G18	25	20	5	0	60	2/3	92		good	W		S	Tested with ballute, slagged up
125	6/72	35	15 G18	25	20	5	0,	60	2/2				W		F	Delay failure
126	6/72	35	15 G18	25	20	5	0	60	2/2	80		good	W		F	Good ignition, slagged up in mid burn, after slag ejection flame good, range approx 300 meters
127	6/72	35	15 G18	25	20	5	0	60	2/4				W		F	Delay failure
128	6/72	35	15 G18	25	20	5	0	60	2/4	90		good	W		F	Good ejection, good inflation, some slag formation. This formulation is satisfactory except for slagging
129	6/72	25	15 G18	25	30	5	0	60	1/2	119		good/fair	W		S	BaNO3 sub for AP; Very little slag but unit chuffed.

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
130	6/72	30	15 G18	25	25	5	0	60	2/4	93		good	W	20	S	BaNO3 Sub for AP; some slagging
131	6/72	40	15 G18	25	20	0	0	60	2/4	67		good	W	59	S	BaNO3 sub for NH4CL; some slagging but expelled easily.
132	6/72	40	15 G18	25	15	5	0	60	2/4	69		good	W	30	S	BaNO3 sub for AP
133	6/72	25	20 G18	25	30	0	0	60	2/4	70		good	W	79	S	Slag formed, some expelled.
134	6/72	35	15 G16	30	20	0	0	60	2/4	118		good fair				Binder sub for NH4CL; some yellow in flame.
135	6/72	30	20 G18	30	20	0	0	60	2/4	77		g0od	W	101	S	Mg sub for BaNO3; good color; expelled slag ok.
136	6/72	25	20 G18	30	25	0	0	60	2/4	86		good	W	94	S	Expelled slag well; smooth burn; good color.
137	6/72	20	20 G18	30	30	0	0	60	2/4	120		fair	W	39	S	Chuffed loudly; flame green during chuffing but poor color otherwise
138	6/72	25	20 G18	30	25	0	0	60	2/4				W	63	S	Good color; some chuffing; expelled slag ok; slight yellow tint. at tip.
139	6/72	25	22.5 G18	30	22.5	0	0	60	2/4	87		good	W	41	S	Expelled slag ok.
140	6/72	22.5	18 G18	27	22.5	0	10	60	2/4	62		good	W	123	S	Chromic Acetate added 10% for each component.

DATA SHEET

40MM FLOATING FLARE

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
141	6/72	25	20 G18	30	25	0	0	60	2/4	99		good fair	W		F	Units functioned satisfactorily; 5 sec delay.
142	6/72	25	20 G18	30	25	0	0	60	2/4	105		good fair	W		F	5.5 sec delay
143	6/72	25	20 G18	30	25	0	0	60	2/4	89		good fair	W		F	5.0 sec delay
144	6/72	25	20 G18	30	25	0	0	60	2/4	85		good fair	W		F	5.5 sec delay
145	6/72	25	20 G18	30	25	0	0	60	2/4	88		good fair	W		F	5.5 sec delay
146	6/72	25	20 G18	30	25	0	0	60	2/4			good fair	W		S	3.5KM night visibility tests 146 thru 149. More intense than control; color not as good as control. This formulation satisfactory except for color quality.
147	6/72	22.5	18 G18	27	22.5	0	10	60	2/4			good	W		S	Chrom Acetate additive
148	6/72	22.5	18 G18	27	22.5	0	10	60	2/4			g00d	W		S	Chromic Chloride additive; color slightly better than Chromic Acetate however, because CrCL3 is incompatable with Mg Chromic Acetate is the better additive for color.

DATA SHEET

40MM FLOATING FLARE

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
149	6/72	25	20 G18	30	25	0	0	60	2/4			good	W		S	Chrome plated chimney. Color slightly better than with a bare chimney.
150	6/72	35	15 G18	25	20	5	0	60	2/4	86		good	W	40	S	Good color; some slag. Same as s/n 91
151	6/72	35	15 G18	25	20	0	5	60	2/4	69		good	W	38	S	Boric acid additive. Good color, no slag.
152	6/72	35	15 G18	25	25	0	0	60	2/4	66		good	W	35	S	Slagged up after approx 15 secs.
153	6/72	35	15 G18	25	20	5	0	60	2/4	69		good	W	40	S	Large radius machined at the base of the chimney. Slagged as before.
154	6/72	30	15 G18	25	15	15		60	2/4	152		fair	W	15.5	S	Slagged up but expelled ok.
155	6/72	30	20 G18	20	15	15		60	2/4	93		poor	W	12	S	Slagged up; poor function.
156	6/72	30	17.5 G18	27.5	27.5	2.5		60	2/4	33		good fair	W			
157	6/72	35	G18 15	25	20	5	0	60	2/4	82		good				Slagged up, expelled same - not all.
158	6/72	35	12.5 G18	25	20	7.5	0	60	2/4	99		fair good				Last 2/3 of burn was good color.

DATA SHEET

40MM FLOATING FLARE

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
159	6/72	35	15 G18	25	20	5	0	60	2/4	71		good				Slagged up.
160	6/72	25	G18 25	25	25		0	60	2/4	72		good		180		Expelled slag o. k.
161	6/72	32.5	17.5 G18	30	20		0	60	2/4	72		good		46		Slagged up.
162	6/72	25	25 G18	25	25		0	60	2/4	70		good	W		F	Unit functioned o. k. Expelled large chunk of slag.
163	6/72	25	25 G18	25	25		0	60	2/4	75		good	W		F	"
164	6/72	25	25 G18	25	25		0	60	2/4	75		good	W		F	"
165	6/72	25	25 G18	25	25		0	60	2/4	-		good	W		F	Unit did not expel slag. Ballute ruptured at 30 sec., unit sank.
166	6/72	25	25 G18	25	25		0	60	2/4	-		good	W		F	Unit did not expel slag. Ballute ruptured at 40 sec, unit sank.
167	6/72	35	17.5 G18	25	20	2.5	0	60	2/4	75		good	W	61	S	Good unit.
168	6/72	30	20 G18	30	20	0	0	60	2/4	73		good	W	104	S	Good - color somewhat yellow.
169	6/72	30	20 G18	30	20	0	0	60	2/4	75		good	W		F	Ejected 75 feet from gun. Unit burned under H_2O.
170	6/72	30	20 G18	30	20	0	0	60	2/4	71		good	W		F	Five second delay - unit functioned satisfactorily.

40MM FLOATING FLARE DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
171	6/72	30	20 G18	30	20	0	0	60	2/4			good	W		F	4.9 second delay. Ballute ruptured, unit sank.
172	6/72	30	20 G18	30	20	0	0	60	2/4	72		good	W		F	4.7 sec delay. Unit functioned o.k.
173	6/72	30	20 G18	30	20	0	0	60	2/4	77			W		F	7.4 second delay. Ejected under H_2O. Functioned o.k.
174	6/72	25	20 G18	30	25	0	0	60	2/4	92		good	W		S	3.5 km night test.
		NEW FORMULATION.														
175	6/72	25	20	30	25	0	0	60	2/4				W	more	S	Much brighter. Poor color at first.
		OLD FORMULATION (control)														
176	6/72	35	10	25	20	10	0	60	2/4		better		W		S	
		Chrom plated chimney.														
177	6/72	25	20	30	25	0	0	60	2/4		better to start		W	more	S	Some better.
178	6/72	25	20	30	25	0	0	60	2/4		Not as good		W	same	S	
		NEW FORMULATION														
179	6/72	Chromic Acetate 22.5	18	27	22.5	0	10	60	2/4	50-60			W		S	
180	6/72	Chromic Chloride 22.5	18	27	22.5	0	10	60	2/4	50-60			W		S	Greener, better. Chrome Chloride reacts with Mag.
181	6/72	35	10 G18	25	20	10	0	60	2/4			same	W	same	S	
182	6/72	35	10 G18	25 (control)	10	10	0	60	2/4			same	W	same	S	

40MM FLOATING FLARE

DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
183	6/72	Chrom Chimney 25	20	30	25	0	0	60	2/4				W		S	
184	6/72	OLD FORMULATION 35	10	25	20	10	0	60	2/4				W		S	
185	6/72	25	20 G18	30	25	0	0	60	2/4	95		good	W		S	Burn with control round.
186	6/72	35	10 G18	25	20	10	0	60	2/4				W		S	Control round.
187	6/72	25	20 G18	30	25	0	0	60	2/4	93		good green	W	good	S	Burn alone.
188	6/72	REPEAT TEST 185.								90		good green	W		S	
189	6/72	REPEAT TEST 187.								87		dim green	W	*	S	Fog coming in. *Lower than above.
190	6/72	Standard	Yellow.							105		good yellow	W	good	S	
191	6/72	Standard	Red.							78		good red	W	good	S	
192	6/72	25	20 G18	30	25	0	0	60	2/4	95		green	W		F	Delay 5.2 sec. Unit tumbled, laid on side in water.
193	6/72	25	20 G18	30	25	0	0	60	2/4	93		green	W		F	Delay 5.2 sec. Unit wobbled in flight.
194	6/72	25	20 G18	30	25	0	0	60	2/4	91		green	W		F	Delay 5.0 sec. Ejection o.k., sank then surfaced at 30 sec.

40MM FLOATING FLARE — DATA SHEET

Test Series 3 - Multiple Substitution

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
195	6/72	Standard Red Formulation.								76		red	W		F	Delay 5.0 sec. Ejection o.k., good performance.
196	6/72	Standard Yellow Formulation								115		yellow	W		F	Delay 5.0 sec. Ejection o.k., good performance.
197	6/72	25	20 G18	30	25	0	0	60	2/4	90		green	W		F	Delay 4.8 sec. Ejection o.k., sank but burned.
198	6/72	Standard Yellow Formulation								115		yellow	W		F	Delay 5.0 sec. Ejection o.k., good performance.
199	6/72	Standard Red Formulation														Ignition transfer failure.
200	6/72	Standard Red Formulation								74		red	W		F	Delay 4.9 sec. Ejection o.k., good performance.
201	6/72	25	20 G18	30	25	0	0	60	2/4	80		green	W		F	Good performance. Ballute o.k.
202	6/72	25	20 G18	30	25	0	0	60	2/4	88		green	W		F	Delay 5.0 sec. Good performance. Ballute o.k.
203	6/72	25	20 G18	30	25	0	0	60	2/4	94		green	L		F	Excessive gun recoil. Unit hit in mud. Ballute split seam 1 inch.

APPENDIX F

PHASE I DEVELOPMENT AND QUALIFICATION TEST DATA

APPENDIX F - 40MM FLOATING FLARE DATA SHEET

PHASE I DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Intensity Candlepower	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
204	7/14	25	20 G18	30	25 AP 400μ			60	2/4	90.5			W		F	Good 100%;new barrel; delay OK; stability OK
205	7/14	25	20 G18	30	25 AP 400μ			60	2/4	86			L		F	Landed in mud; new barrel; good 100%;delay OK; stability OK
206	7/14	25	20 G18	30	25 AP 400μ			60	2/4	90.5			W		F	Good 100%; new barrel; delay OK; stability OK
207	7/14	25	20 G18	30	25 AP 400μ			60	2/4	92			W		F	Sank but burned fu ll duration; new barrel; delay OK; stability OK
208	7/14	25	20 G18	30	25 AP 400μ			60	2/4	90			W		F	Good 100%;delay ok: stability OK; new barrel
209	7/31	25	20 G18	30	25 AP 400μ			60	2/4			grn	W		F	First fire failed to light; delay OK; stability OK; green
210	7/31	25	20 G18	30	25 AP 400μ			60	2/4			grn	W		F	Good 100%; green
211	7/31	STANDARD YELLOW FORMULATION										yel	W		F	Delay chunked out; first fire failed to light; stability OK
212	7/31	25	20 G18	30	25 AP 400μ			60	2/4			grn	W		F	Delay OK; first fire ignited; but vented; went propulsive; stability OK
213	7/31	25	20 G18	30	25 AP 400μ			60	2/4			grn	W		F	Delay OK; first fire OK; stabilityOK bullute was cut during assy; sank
214	7/31	25	20 G 18	30	25 AP 400μ			60	2/4			grn	W		F	Delay OK, but vented, stability OK, first fire ignited, functioned OK

40MM FLOATING FLARE FLIGHT TEST SERIES

1. Old Bodies
2. Delay batch no. 2 (suspect separation or output mix at press interface)
3. New ogives
4. First fire dried before pressing
5. all green units

DATA SHEET

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
215	8/9	25	20 G18	30	25 AP 400	~		60	2/4	94		grn	W	5.5	F	Control rounds; chuffed 1/2 way thru burn; functioned OK
216	8/9	25	20 G18	30	25 AP 400	~		60	2/4/1	101		grn	W	5.3	F	1 GM B.P. in 1st fire; ejection loud functioned OK
217	8/9	25	20 G18	30	25 AP 400	~		60	2/4	66		grn	W	4.5 report	F	Control rounds; ejection 50 ft; Chimney ejected at 66 secs.
218	8/9	25	20 G18	30	25 AP 400	~		60	2/4/1	—		—	W	—	F	1 gm B.P. in 1st fire; delay vented no ejection; sank on impact
219	8/9	25	20 G18	30	25 AP 400	~		60	2/4	95		grn	W	5.2	F	Control rounds; functioned OK
220	8/9	25	20 G18	30	25 AP 400	~		60	2/4/1	98		grn	W	5.6	F	1 gm B.P. in 1st fire; ejection loud; functioned OK
221	8/9	25	20 G18	30	25 AP 400	~		60	2/4	—		—	W	—	F	Control rounds; delay glowed but didn't spit; no ej.; sank on impact
222	8/9	25	20 G18	30	25 AP 400	~		60	2/4/1	90		grn	W	5.5	F	1 gm BP in 1st fire; functioned OK
223	8/9	25	20 G18	30	25 AP 400	~		60	2/4	90		grn	W	5.3	F	Control rounds; Functioned OK
224	8/9	25	20 G18	30	25 AP 400	~		60	2/4/1	—		—	W	—	F	1 gm B.P. in 1st fire; launcher observed nothing; DUD; ballute was tight in body

Conclusion:
- 3 out of 5 control rounds functioned OK
- 1 out of 5 control rounds were Duds
- 1 out of 5 control rounds ejected the chimney
- 3 out of 5 B.P. rounds functioned OK
- 2 out of 5 B.P. rounds were duds.

DATA SHEET

40MM FLOATING FLARE FLIGHT TEST SERIES

1. New bodies
2. New delays (3rd batch) (20 new procedure)
3. New magnesium (reade)
4. Ingredients dried overnight at 150°F
5. All green units

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
225	8/16	25	20 G18	30	25 AP 400μ			60	2/4	87		good grn	W	5.1	F	Ejection loud; Functioned OK
226	8/16	25	20 G18	30	25 AP 400μ			60	2/4	87		good grn	W	4.6 sound	F	Ejection soft Functioned OK
227	8/16	25	20 G18	30	25 AP 400μ			60	2/4	81		good grn	W	4.7	F	Ejection soft Functioned OK
228	8/16	25	20 G18	30	25 AP 400μ			60	2/4	89		good grn	W	5.2	F	Wobbled in flight; ejection soft; Functioned OK
229	8/16	25	20 G18	30	25 AP 400μ			60	2/4	60		good grn	W	5.5	F	Stable flight; ballute ruptured; Functioned OK
230	8/16	25	20 G18	30	25 AP 400μ			60	2/4	90		good grn	W	4.4 sound	F	Wobbled slightly in flight; Full range; functioned OK
231	8/16	25	20 G18	30	25 40 400μ			60	2/4	87		good grn	W	5.1	F	Stable flight; functioned OK
232	8/16	25	20 G18	30	25 AP 400μ			60	2/4	71		good grn	W	5.6	F	Wobbled slightly in flight; Couldn't eject slag; ~~Functioned OK~~
233	8/16	25	20 G18	30	25 AP 400μ			60	2/4	86		good grn	W	5.4	F	Full range; ejection loud; ballute vented at 60 sec but flame recovered ~~functioned OK~~
234	8/16	25	20 G18	30	25 AP 400μ			60	2/4	93		good grn	W	5.0	F	Full range; functioned OK

Conclusions: The new delay manufacturing technique solved the dud problem. 10 out of 10 functioned OK.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. New bodies
2. New delays (4th batch 120)
3. New ogive
4. Ingredients dried before mixing
5. Body burr removed
6. All green units

Purpose of Tests: Check out new assy tech. and proof the new batch of delays

DATA SHEET

Serial Number	Test Date	Percent Composition: Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives	Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
235	8/31	25	20 G18	30	25 AP 400μ			60	2/4	94		—	W	5.5	F	Full range; tumbled after ejection; burned underwater. No orifice
236	8/31	25	20 G18	30	25 AP 400μ			60	2/4	100		—	W	5.5	F	Full range; tumbled after ejection; burned underwater. No orifice
237	8/31	25	20 G18	30	25 AP 400μ			60	2/4	63		good grn	W	5.4	F	Full range; good ejection; burned OK 1st 30 sec. chimney plugged for 10 sec; ejection slag & sank at 63 sec; no orifice
238	8/31	25	20 G18	30	25 AP 400μ			60	2/4	60		good grn	W	5.3	F	Full range; good ejection; tumbled slightly after ejection, sank on impact; came up; blew out water, reignited; burned 60 sec, sank; no orifice
239	8/31	25	20 G18	30	25 AP 400μ			60	2/4	87		intense grn	L	5.8	F	Fired straight up; ballute failed to inflate; seam broken. no orifice.
240	8/31	25	20 G18	30	25 AP 400μ			60	2/4	92		intense grn	W	5.4	F	Full range; ejection soft; functioned OK; orifice
241	8/31	25	20 G18	30	25 AP 400μ			60	2/4	97		intense grn	W	5.3	F	Full range; ejection soft; functioned OK; orifice
242	8/31	25	20 G18	30	25 AP 400μ			60	2/4	93		intense grn	W	5.1	F	Full range; ejection soft; functioned OK; orifice
243	8/31	25	20 G18	30	25 AP 400μ			60	2/4	95		intense grn	W	5.0	F	Full range; ejection soft; ejected on water; floated OK; functioned OK; Orifice
244	8/31	25	20 G18	30	25 AP 400μ			60	2/4	95		intense grn	W	4.5 sec sound	F	Full range; ejection soft; floated OK; functioned OK; orifice

Conclusion: 0 of 5 units functioned OK without orifice; 5 of 5 OK with o. All units assembled without orifice in chimney; last 5 units rebuilt with new ogives and the orifice added.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. Body fwd land snug fit inside gun
2. New bodies from first lot
3. New delays (4th batch 120)
4. New Ogives
5. New batch of first fire (different container of teflon)
   This batch has more uniform dist. because screening before adding to mix
   prior to this the teflon was not screened but screened after mixing.
6. Most past history did not screen the teflon before or after mixing
7. Teflon-7A used in first fire
8. Units 245-249 ballute cut during crimping
9. All green units

Serial Number	Test Date	Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives	Composition Weight (gr	First Fire Weight (gr	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec	Static or Flight Test	Configuration and/or Remarks
245	9/8	25	20 G18	30	25 AP 400μ			60	2/4	94		good grn	W	6.2	F	Functioned at water impact went under 5 sec. came up full range functioned OK
246	"	"	"	"	"			"	"	65		"	L & W	7.0	F	long range delay function, deployed almost on grd. can hit rock & leaked 72 sec to B. Othrew into water functioned OK
247	"	"	"	"	"			"	"	85		"	W	6.5	F	shot higher elev. had trouble ejecting slag burned OK deployed in air functioned OK
248	"	"	"	"	"			"	"	113			W	6.2	F	deployed in air spirled into water sank stuck in mud on bottom hole burned in ballute
249	"	"	"	"	"			"	"	81		good grn	L	5.9	F	deployed in air spirled tear in ballute seam landed on the ground
250	"	"	"	"	"			"	"	106			W	5.6	F	deployed in air, sank burned under water deployment looked OK could have spirled
251	"	"	"	"	"			"	"	70		good grn	W	5.8	F	deployed in air, spirled, sank came up, 10 sec burned OK sank at 20 sec came up tilted over on side and sank
252	"	"	"	"	"			"	"	97			W	5.9	F	deployed in air, spirled, burn hole in ballute, sank in very shallow water
253	"	"	"	"	"			"	"	83		good grn	W	6.0	F	deployed in air, spirled, burned OK tilted over in 60 sec came back up straight functioned OK
254	"	"	"	"	"			"	"	85			W	5.5	F	deployed in air, sank, burned underwater

Conclusions: 6 out of 10 functioned OK - ballutes cut during crimping did not cause a failure
S/N 246 rifling marks on body of fwd land
S/N 248 tight in loading flare into body; 4 holes cut in ballute during assy
Some had a double report on ejection especially S/N 252 and 253

40MM FLOATING FLARE FLIGHT TEST SERIES

1. New bodies
2. New delays (4th batch)
3. New ogives repacked on S/N 258 after inspection; S/N 259 repacked with original ogive; s/N 255 & 256 repacked with white ogives.
4. All torn down and inspected

DATA SHEET

Purpose of tests: to check reason for ballute burns, torn stitching in previous test group

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
255	9/8	25	20 G18	30	25 AP 400μ			60	2/4	85		good grn	W	6.8	F	ejection slow; full range; hit shallow water; floated OK functioned OK
256	9/8	"	"	"	"			"	"	93		"	"	6.1	"	ejected high-sounded good; stable into water-hit in shallow water; functioned OK
257	9/8	"	"	"	"			"	"	95		"	"	6.1	"	ejection OK - tumbled, sank. burned under water
258	9/8	"	"	"	"			"	"	94		"	"	5.7	"	ejected softly just before water impact sank for 5 sec came up OK hissed before deployment; functioned OK
259	9/8	"	"	"	"			"	"	84		"	"	4.1 snd	"	Hissed before impact & deployed at impact, functioned OK
				Conclusion:		4 out of 5 functioned OK.										

Conclusion: 4 out of 5 functioned OK.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. New ogive
2. New bodies
3. New delays (120 batch)
4. New first fire (ingre. unscreened - screen final mix screened 20 mesh method

Purpose of tests: check out effect of first fire processing on sinking problem

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
260	9/11	25	20 G18	30	20 AP 400 μ			60	2/4	90-94		good grn	W	5 to 5.5	F	good loud ejection; full range; functioned ok
261	9/11	"	"	"	"			"	"	"		"	"	"	"	Same as S/N 260
262	9/11	"	"	"	"			"	"	"		"	"	"	"	same as S/N 260, except seam split in ballute
263	9/12	"	"	"	"			"	"	"		"	"	"	"	same as S/N 260
264	9/11	"	"	"	"			"	"	"		"	"	"	"	same as S/N 260
265	9/12	"	"	"	"			"	"	84		"	"	5.0	"	full range, ej. loud, ej. at water ballute vented at slag ej. seam split; functioned ok
266	9/12	"	"	"	"			"	"	90		"	"	5.0	"	same as S/N 265
267	9/12	"	"	"	"			"	"	95		"	"	4.2 snd	"	full range ej. med loud, ej. just above water; ballute vented at slag, ej functioned ok
268	9/12	"	"	"	"			"	"	95		"	"	5.0	"	full range ej. med. loud; ejected just above water, slag ejected easily-no ballute flaming, functioned ok
269	9/12	"	"	"	"			"	"	86		int grn	"	no data	"	full range ej. loud, ejected just above water slag ejected easily no ballute flaming flame very intense

Conclusion: All units functioned ok - unscreened ingreds apparently solved sinking problem, however 4 units had broken seam stiching

40MM FLOATING FLARE FLIGHT TEST SERIES

1. New ogive
2. New bodies
3. New delays
4. First fire (teflon unscreened) (mix screened)
5. repacked ballutes
6. batch No. 1 S/N 270-274; batch No. 2, S/N 275-279 - Purpose of tests: Green batch qualification

DATA SHEET

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
270	9/13	25	20 G18	30	25 AP 400 μ			60	2/4	95		good grn	W	6.6	F	small low sound before impact deployed underwater, came up full range; floated ok; functioned ok
271	"	"	"	"	"			"	"	85		"	"	5.5	"	full range, soft ejection, hole burned in top, functioned ok
272	"	"	"	"	"			"	"	100		"	"	5.0	"	full range; sank; came up; floated on side; soft ej; functioned ok
273	"	"	"	"	"			"	"	90		"	"	5.2	"	full range, med. loud ejection, did not sink, functioned ok
274	"	"	"	"	"			"	"	92		"	"	5.1	"	full range, loud ejection; did not sink, functioned ok
275	"	"	"	"	"			"	"	87		"	"	5.5	"	slightly short range; ejected just above water, sank, came up, functioned ok, med. loud report, on ejection
276	"	"	"	"	"			"	"	93		"	"	5.2	"	full range; ejected above water, did not sink, functioned ok, med loud report on ejection
277	"	"	"	"	"			"	"	95		"	"	5.1	"	full range, ejected just above water, enter water sideways, sank, came up in 60 sec. but stayed on side, med loud report, split in seam.
278	"	"	"	"	"			"	"	90		"	"	5.3	"	slightly short range, ejected just before impact, med loud report, sank, came up, functioned ok
279	"	"	"	"	"			"	"	92		"	"	5.3	"	full range, ejection normal loud report, came in burning hot flame, did not sink, functioned ok

Conclusion: 8 out of 10 functioned ok - 1 from each batch floated on sides (probably ballute seam failure) S/N 277 had small hole during assembly. Both batches ok to use.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. S/N 280-284 repack ballute; S/N 285-289, new ballutes
2. New cases
3. New ogives
4. First fire (teflon unscreened) (mix screened)
5 New delays

DATA SHEET

Purpose of tests: Green batch qualification

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
280	9/14	25	20 G18	30	25 AP 400			60	2/4	68		good grn	W	5.2	F	Slightly short range;ej. on water;sank, came up, couldn't ej. slag, burn short
281	"	"	"	"	"			"	"	89		"	"	5.3	"	full range;ej. just above water, did not sink;functioned ok, ej. slag ok, med. loud report.
282	"	"	"	"	"			"	"	92		"	"	4.2 snd	"	Full range; ej. above water, did not sink, med loud report, ej. slag easily, functioned ok.
283	"	"	"	"	"			"	"	85		"	"	4.3 snd	"	Full range; ej. above water, spiralled in; did not sink, ej. slag; functioned ok, med. loud report.
284	"	"	"	"	"			"	"	89		"	"	5.1	"	Slightly short range, ej. above water, did not sink, med loud report; ej. slag, functioned ok.
285	"	"	"	"	"			"	"	87		"	"	4.6 snd	"	Full range; ej. above water, did not sink med loud report, ej. slag, functioned ok.
286	"	"	"	"	"			"	"	85		"	"	5.0	"	Slightly short, range, ej. above water, did not sink, med loud report, ejected slag, functioned ok.
287	"	"	"	"	"			"	"	90		"	"	4.7	"	Slightly short range, ejected above water did not sink, med loud report, ejected slag easily, functioned ok.
288	"	"	"	"	"			"	"	100		-	"	4.7	"	Slightly short range; ejected above water low report, no flame, sank on impact burned underwater.
289	"	"	"	"	"			"	"	92		good grn	"	4.8	"	Slightly short range, ejected above water loud report, flame before impact, did not sink, vented before slag ejection at low pressure, functioned ok.

Conclusions: 8 out of 10 functioned ok. One burned short; one sank.
Post test results: S/N 280 chimney full of slag; S/N 281 284 285 287 ballute ok; S/N 286, 289 1/2 inch break in seam.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. New ballutes
2. New bodies
3. New ogives
4. first fire (teflon unscreened) (mix screened)
5. New delays

Purpose of test: Green batch qualification

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Bur (in.	Col Qua	Wat Lar	Del	Stat Fli	
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
290	9/14	25	20 G18	30	25 AP 400μ			60	2/4	93		good grn	W	5.6	F	full range;ejected at water impact soft ej; flew back into air & functioned ok.
291	"	"	"	"	"			"	"	60		"	"	5.2	"	slightly short range;no report at ej. did not sink, could not ej. slag, floated ok.
292	"	"	"	"	"			"	"	95		"	"	5.3	"	full range;soft ej;above water; flamed good during decent;did not sink, ej. slag;functioned ok
293	"	"	"	"	"			"	"	92		"	"	5.1	"	slightly short range;ej. above water; soft report;flame good during decent; did not sink;ej. slag;functioned ok
294	"	"	"	"	"			"	"	86		"	"	4.1 snd	"	slightly short range;ej. above water; loud report;flame good during decent; did not sink;ej. slag, functioned ok
295	"	"	"	"	"			"	"	93		"	"	5.0	"	full range;ej. above water;did not sink;med report;flame good during decent, ej. slag;functioned ok
296	"	"	"	"	"			"	"	88		"	"	5.1	"	slightly short range;very soft ej;smoked coming in, ej. at water impact, did not sink;functioned ok;ej. slag.
297	"	"	"	"	"			"	"	105		"	"	5.1	"	slightly short range;ej. above water; med report;laid on side but flame was visible some times
298	"	"	"	"	"			"	"	96		"	"	5.0	"	Full range;ej. above water; loud report; did not sink;flame good during decent; functioned ok
299	"	"	"	"	"			"	"	87		"	"	4.8	"	slightly short range;ej. abcve water; did not sink;loud report;flame good during decent, ej. slag, functioned ok
300	"	"	"	"	"			"	"	86		"	"	5.0	"	full range;med loud report, ej. above water, did not sink, flame good during decent;ej. slag;functioned ok
301	"	"	"	"	"			"	"	97		"	"	4.8	"	full range;ej. just above water;sank; burned under water

Conclusion: 10 out of 12 functioned ok, one burned short; one sank.
Post test results; S/N 291, 292, 293, 296, 298, 300 ballute ok; S/N 294, 297, 299 1/2 inch break in seam;
S/N 295 part of inner seam broken

40MM FLOATING FLARE SPECIAL TEST SERIES

1. No ballute
2. Quickmatch ignited
3. Static test in flare tunnel
4. All green units

DATA SHEET

Purpose of Tests: Evaluated effect of plated chimneys on color quality

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
302	9/20	25	20 G18	30	25 AP 400μ			60	2/4	88		intense grn	W		S	Zinc plated chimney. no effect detected. functioned ok.
303	"	"	"	"	"			"	"	90		"	"		"	Cad plated chimney. No effect detected functioned ok
304	"	"	"	"	"			"	"	91		"	"		"	Nickel plated chimney. No effect detected. functioned ok.
305	"	"	"	"	"			"	"	93		"	"		"	Zinc plated chimney. No effect detected. functioned ok.
306	"	"	"	"	"			"	"	93		"	"		"	Cad plated chimney. No effect detected. functioned ok.
307	"	"	"	"	"			"	"	94		"	"		"	Nickel plated chimney. No effect noted. functioned ok.

Conclusion: The type of plating doesn't affect the color quality of the green flare.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. Mills ballutes no. 40 thd.
2. New bodies
3. New ogives
4. New delays
5. Wind blowing against direction of flight
6. S/N 308-312 red
   313-317 yellow

DATA SHEET

Purpose of tests: Red & Yellow batch qualification

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
308	9/20	40	5 22μ	25	30 AP 50μ			68	2/4	81		dim red	W	5.3	F	Full range, ej. on water, sank, came up, no ej. of slag, functioned ok.
309	"	"	"	"	"			"	"	82		"	"	5.2	"	Full range, ej. above water, spirled into water, sank, came up, chuffed, sank.
310	"	"	"	"	"			"	"	76		"	"	5.1	"	Full range, ej. above water, med loud report. Good flame during decent, burned OK. Functioned ok.
311	"	"	"	"	"			"	"	79		"	"	5.2	"	Full range; ej. just above water, weak report, floated ok, functioned ok.
312	"	"	"	"	"			"	"	78		"	"	5.3	"	Full range, ej. above water, low to med report, floated ok; functioned ok.
313	"	45	15 22μ	"	15 AP 50μ			60	"	89		intense yel.	"	5.3	"	Full range, ej. above water, med to loud report, good flame on decent, functioned ok.
314	"	45	"	"	"			"	"	100		"	"	5.3	"	Full range, ej. above water, med to loud report, good flame on decent, intense flame, functioned ok.
315	"	"	"	"	"			"	"	91		"	"	5.2	"	Slightly short, ej. above water, low report, tumbled decent, burned ok functioned ok.
316	"	"	"	"	"			"	"	97		"	"	5.2	"	Full range, ej. above water, med to loud report, good flame during decent, did not sink, functioned ok.
317	"	"	"	"	"			"	"	100		"	"	5.5	"	Slightly short range, ej. above water, low report, sank on impact, came up, floated ok, functioned ok

Conclusion: 4 out of 5 functioned ok. Red units - 1 unit had large hole burned in top of ballute.
5 out of 5 functioned ok. yellow units

40MM FLOATING FLARE FLIGHT TEST SERIES

1. Mills ballutes
2. New bodies
3. New ogives
4. Same first fire as 9-20-72
5. Most wind of any previous test day.
6. Bodies deburred
7. Orifice used in chimney
8. S/N 318-321 green
   S/N 322-326 Red
   S/N 327-329 yellow

DATA SHEET

Purpose of Tests: Check out Mills ballute with green, red & yellow qual units.

Serial Number	Test Date	Nitrate	Magne	Binder	Second Oxidiz	Coolar	Other Additi	Compo Weigh	First Weigh	Burn T (secon	Burn I (in./s	Color Qualit	Water Land	Delay	Static Flight	
318	9/21	25	20 350μ	30	25 AP 400μ			60	2/4	101		int grn	W	5.5	F	Full range, ej. just above water, sank, came up, functioned ok.
319	"	25	"	"	"			"	"	94		"	W	5.2	F	Full range, ej. above water, loud report sank, came up, floated ok, difficulty in slag ejection, functioned ok.
320	"	25	"	"	"			"	"	95		"	W	5.1	F	Full range, ej. above water, sank, came up, loud report, trouble in slag ejection functioned ok.
321	"	25	"	"	"			"	"	92		"	W	5.1	F	Full range, ej. above water, loud report, did not sink, slag ej. normal, functioned ok.
322	"	40	5 22μ	25	30 AP 50μ			68	"	79		-	W	5.2	F	Full range, ej. above water, med loud report, spirled decent, sank, did not come up.
323	"	40	"	"	"			"	"	-		-	W	5.1	F	Full range, heard soud just above impact no ejection, no burn.
324	"	40	"	"	"			"	"	82		good red	W	5.0	F	Slightly short range, ej. at water impact floated ok, functioned ok.
325	"	40	"	"	"			"	"	85		"	W	5.1	F	Full range, ej. above water, low report sank came up, flame did not start immediately; functioned ok.
326	"	40	"	"	"			"	"	83		"	W	5.3	F	Full range, ej. above water, low report functioned ok, flame went out, temporarily during end of burn.
327	"	45	15 22μ	"	15 AP 50μ			60	"	95		int yel.	W	5.2	F	Full range, ej. above water, loud report spirled during decent, did not sink, functioned ok.
328	"	45	"	"	"			"	"	98		"	W	5.2	F	Full range, ej. above water, med loud report, sank, came up, functioned ok.
329	"	45	"	"	"			"	"	85		"	W	5.1	F	Full range, ej. just above water, sank, burned under water, came up near end of burn, floated on side, med loud report

Conclusions: 4 out of 4 green functioned ok
3 out of 5 red functioned ok (1 sank, 1 dud)
2 out of 3 yellow functioned ok (1 floated on side)

40MM FLOATING FLARE FLIGHT TEST SERIES
1. S/N 330, 331 yellow
2. S/N 330, 331 cont. of test of S/N 327, 328, 329

DATA SHEET

Same data as previous units

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
330	9/21	45	15 22μ	25	15 AP 50μ			60	2/4	100		int. yel.	W	5.4	F	Full range, ejected above water, med. loud report, did not sink, functioned ok.
331	"	"	"	"	"			"	"	95		"	"	"	"	Full range ejected above water, low report did not sink good flame during decent, functioned ok.

Conclusions: 2 out of 2 yellow units functioned ok

S/N 332, 333 lab static tests
S/N 332, 333 from same lot as S/N 322-326

40MM FLOATING FLARE SPECIAL TEST SERIES

DATA SHEET

PURPOSE OF TESTS: FIND OUT WHY RED FLAME OUT OCCURRED IN FLIGHT TESTS

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
332	9/21	40	5 22μ	25	30 AP 50μ			68	2/4	86	good red	W			S	Static test lab red burned normally with a stand off flame
333	"	"	"	"	"			"	"	79	"	"			"	Static test lab red burned normally with a stand-off flame

Conclusion: Mix appears OK but batch rejected anyway due to poor flight tests - all mix ingred will be dried overnight and new candles of red made tomorrow.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. Reused ballutes made by Chemtronics
2. New green bodies
3. Ingr. dried overnight
4. Delays (AAI)

DATA SHEET

PURPOSE OF TESTS: Red batch qualification

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
334	9/22	40	5 22μ	25	30 AP 50μ			68	2/4	75		good red	W	6.1	F	Fired high QE deployed high-med loud report-stable on decent, full balluate functioned OK
335	"	"	"	"	"			"	"	74		"	"	5.2	"	Hex delay-fired high QE dployed high, soft ejection, stable on decent, full ballute-functioned OK
336	"	"	"	"	"			"	"	60		-	"	5.0	"	High QE, deployed at max altitude-soft ejection unstable decent sank on impact
337	"	"	"	"	"			"	"	76		good red	L & W	4.9	"	Med high QE; deployed high;med ejection report;stable decent hit ground, threw into water;functioned ok;full ballute

3 out of 4 functioned OK
1 sank on impact - probable cause - hole burned in ballute

40MM FLOATING FLARE SPECIAL TEST SERIES

Purpose of Tests: check out new red mix for longer duration, also double first fire charge.

DATA SHEET

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
338	9/26	40	10 350μ	25	25 AP 50μ			62	4/ 0	81		int. red	W		S	Lab static test functioned ok
339	"	"	"	"	"			66	4/ 4	91		"	"		"	Lab static test, burn thru cannister near end not in deep enough water.

Conclusion: New composition appears to increase burn time of red unit.
No problem with double first fire

APPENDIX G

PHASE II DEVELOPMENT AND QUALIFICATION TEST DATA

40MM FLOATING FLARE STATIC & FLIGHT TEST SERIES

1. All new parts
2. Bodies dried at 115°F for 72 hours
3. Mix components dried at 160°F for 24 hours

APPENDIX G - 40MM FLOATING FLARE
PHASE II DEVELOPMENT AND QUALIFICATION
TEST DATA

DATA SHEET

PURPOSE OF TESTS: PHASE II GREEN QUALIFICATION

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
340	12/11	25	20 350μ	30	25 AP 400μ			65	3/4	60			W	OK	F	Ejected OK, hole in ballute
341	"	"	"	"	"			"	"	86			"	"	"	Functioned OK
342	"	"	"	"	"			"	"	88			"	"	"	Functioned OK
343	"	"	"	"	"			"	"	88			"	"	"	Functioned OK
344	"	"	"	"	"			"	"	45			"	"	"	Did not eject slag ballute seam split. Unit sank
345	"	"	"	"	"			"	"	85			"	"	"	Functioned OK
346	"	"	"	"	"			"	"	85			"	"	"	Ejected underwater, Functioned OK
347	"	"	"	"	"			"	"	86			"	"	"	Functioned OK
348	"	"	"	"	"			"	"	50			"	"	"	Did not eject slag. Ballute seam split
349	"	"	"	"	"			"	"	40			"	"	"	Did not eject slag. Ballute seam split
350	"	"	"	"	"			"	"	71			"	"	"	Did not eject slag. Ballute seam split

Conclusions: 6 out of 11 functioned OK. One unit had a hole in the ballute and four had slag ejection problems

40MM FLOATING FLARE STATIC & FLIGHT TEST SERIES

1. All new parts
2. Bodies dried at 115°F for 72 hours
3. Mix components dried at 160°F for 24 hrs and assembled warm
4. 1/2 of units taken from initial assembly and 1/2 taken at random during assembly. Purpose of tests: Phase I[I] green qualification and to check out new chimney insert design
5. Polyethylene chimney insert full length of chimney
6. All green units.

DATA SHEET

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
351	12/14	25	20 350μ	30	25 AP 400μ			65	3/4	88		grn	W	-	S	No slag buildup in chimney. Insert burns away in 10 to 12 sec. Functioned perfectly.
352	"	"	"	"	"			"	"	89		"	"	-	"	Same as S/N 351
353	"	"	"	"	"			"	"	86		"	"	-	"	Same as S/N 351
354	"	"	"	"	"			"	"	85		"	"	OK	F	No slag buildup in chimney. Functioned OK
355	"	"	"	"	"			"	"	90		"	"	"	"	Same as S/N 354
356	"	"	"	"	"			"	"	88		"	"	"	"	Same
357	"	"	"	"	"			"	"	87		"	"	"	"	Same
358	"	"	"	"	"			"	"	88		"	"	"	"	Same
359	"	"	"	"	"			"	"	88		"	"	"	"	Same
360	"	"	"	"	"			"	"	85		"	"	"	"	Same
361	"	"	"	"	"			"	"	85		"	"	"	"	Same
362	"	"	"	"	"			"	"	86		"	"	"	"	Same

Conclusions: 3 static tests showed that a full length insert will help the slag problem in the chimney.

Conclusions: 3 static tests showed that a full length insert will help the slag problem in the chimney.

40MM FLOATING FLARE FLIGHT TEST SERIES

1. All new parts
2. Bodies dried at 115°F for 72 hours
3. Mix components dried at 160°F for 24 hours
4. 1/2 of units taken from initial assy and 1/2 taken at random during assy.
5. Full chimney length insert used.
6. S/N 363 green unit; S/N 364-373 red units

DATA SHEET

Purpose of tests: Phase II Red qualification

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
363	12/14	25	20 350μ	30	25 AP 400μ			65	3/4	88		grn	W	OK	F	No slag buildup in chimney, Functioned OK
364	12/18	40	10 350μ	25	25 AP 50μ			"	"	86		red	"	"	"	Same
365	"	"	"	"	"			"	"	87		"	"	"	"	"
366	"	"	"	"	"			"	"	86		"	"	"	"	"
367	"	"	"	"	"			"	"	88		"	"	"	"	"
368	"	"	"	"	"			"	"	88		"	"	"	"	"
369	"	"	"	"	"			"	"	85		"	"	"	"	"
370	"	"	"	"	"			"	"	89		"	"	"	"	"
371	"	"	"	"	"			"	"	88		"	"	"	"	"
372	"	"	"	"	"			"	"	89		"	"	"	"	"
373	"	"	"	"	"			"	"	85		"	"	"	"	"

Conclusions:
10 out of 10 green units functioned OK with full length chimney inserts.
10 out of 10 red units functioned OK with full length chimney inserts.

40MM FLOATING FLARE FLIGHT TESTS SERIES

Purpose of Tests: Phase II yellow qualification

1. All new parts
2. Bodies dried at 115°F for 72 hours
3. Mix components dried at 160°F for 24 hours and assembled warm
4. 1/2 of units taken from initial assy and 1/2 taken at random during assy
5. Full chimney length insert used
6. Lake covered with 1/2"-1/4" thick ice.
7. S/N 374-381 yellow units; S/N 382 red unit
8. Chimney attached by 3 crimp rolls

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
374	12/20	45	15 22μ	25	15 AP 50μ			56	3/4	98		yel	W	OK	F	No slag buildup in chimney Functioned OK
375	"	"	"	"	"			"	"	99		"	"	"	"	Same
376	"	"	"	"	"			"	"	103		"	"	"	"	Same
377	"	"	"	"	"			"	"	99		"	"	"	"	Same
378	"	"	"	"	"			"	"	101		"	"	"	"	Same
379	"	"	"	"	"			"	"	98		"	"	"	"	Full range Functioned OK
380	"	"	"	"	"			"	"	99		"	"	"	"	Same
381	"	"	"	"	"			"	"	103		"	"	"	"	O-ring tried on chimney/cannister joint. Full range; functioned OK
382	"	40	10 350μ	25	25 AP 50μ			65	"	88		red	"	"	"	Full range - went under ice functioned OK

Conclusions: 8 out 8 yellow units functioned OK with full length chimney insetts
1 out of 1 red unit functioned OK with full length chimney insert

APPENDIX H

PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

1. All Green Units

2. First Fire 19.2B, 18.2 Teflon, 57.6 KNO_3, 5 Binder

DATA SHEET

APPENDIX H - 40MM FLOATING FLARE - PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
383	2/21 73	25	20 350〃	30	25 AP 400〃			64	3/4	-		-	W	Dud	F	Delay glow seen, delay spit; no transfer to first fire; no ejection
384	〃	〃	〃	〃	〃			〃	〃	89		OK	〃	OK	〃	Functioned OK
385	〃	〃	〃	〃	〃			〃	〃	88		〃	〃	〃	〃	Functioned OK
386	〃	〃	〃	〃	〃			〃	〃	-		-	〃	Dud	〃	Delay glow seen, no ejection
387	〃	〃	〃	〃	〃			〃	〃	-		-	〃	〃	〃	Delay glow seen, no ejection
388	〃	〃	〃	〃	〃			〃	〃	83		OK	〃	OK	〃	Functioned OK
389	〃	〃	〃	〃	〃			〃	〃	85		〃	〃	〃	〃	Functioned OK
390	〃	〃	〃	〃	〃			〃	〃	83		〃	〃	〃	〃	Functioned OK - Ejection slow
391	〃	〃	〃	〃	〃			〃	〃	87		〃	〃	〃	〃	Functioned OK
392	〃	〃	〃	〃	〃			〃	〃	87		〃	〃	〃	〃	Functioned OK
393	3/1 73	〃	〃	〃	〃			〃	〃	93		〃	〃	〃	〃	Ejected under H_2O Functioned OK
394	〃	〃	〃	〃	〃			〃	〃	-		-	〃	〃	〃	Ignition transfer, jetted in, no ejection

1. All green units
2. S/N 395-400 std. first fire
3. s/n 401-405 first fire teflon reduced 25%

DATA SHEET

40MM FLOATING FLARE - PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
395	3/1/73	25	20 350μ	30	25 AP 400μ			64	3/4	95		OK	W	OK	F	Functioned OK
396	"	"	"	"	"			"	"	90		"	"	"	"	Funcioned OK
397	"	"	"	"	"			"	"	92		"	"	"	"	Functioned OK
398	3/5/73	"	"	"	"			"	"	-		-	"	"	"	Ignition transfer, jetted in, No ejection
399	"	"	"	"	"			"	"	-		-	"	Dud	"	No ignition, Dud
400	"	"	"	"	"			"	"	-		-	"	Dud	"	No ignition, Dud
401	3/6/73	"	"	"	"			"	"	-		-	"	OK	"	Ejected and burned under water
402	"	"	"	"	"			"	"	89		OK	"	OK	"	Functioned OK
403	"	"	"	"	"			"	"	69		"	"	"	"	Jetted in, ejected and surfaced 20 sec later.
404	"	"	"	"	"			"	"	79		"	"	"	"	Jetted in, ejected and surfaced 10 seconds later.
405	"	"	"	"	"			"	"	89		"	"	"	"	Functioned OK

1. All green units
2. S/N 406-408 No teflon in First Fire
3. S/N 409-413 First Fire in Teflon reduced 75%

DATA SHEET

40MM FLOATING FLARE - PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
406	3/5/73	25	20 350	30	25 AP 400			64	3/4	88		OK	W	OK	F	Functioned OK, ejected very hard, sank immediately after burn out.
407	"	"	"	"	"			"	"	89		"	"	"	"	Functioned OK, same as 406
408	"	"	"	"	"			"	"	87		"	"	"	"	Functioned OK, same as 406
409	"	"	"	"	"			"	"	89		"	"	"	"	Functioned OK, good ejection
410	"	"	"	"	"			"	"	0		-	"	Dud	"	No ignition of delay, no glow seen
411	"	"	"	"	"			"	"	89		OK	"	OK	"	Functioned OK, good ejection
412	"	"	"	"	"			"	"	88		"	"	"	"	Functioned OK, good ejection
413	"	"	"	"	"			"	"	89		"	"	"	"	Functioned OK, good ejection

1. All green units

DATA SHEET

2. First Fire: 67.8 KNO_3, 22.6 B, 4.6 Teflon, 5 Binder

40MM FLOATING FLARE - PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
414	3/7/73	25	20 350	30	25 AP 400			64	3/4	90		OK	W	5.2	F	Functioned OK
415	"	"	"	"	"			"	"	-		=	"	Dud	"	No transfer to F.F., Delay glow, no spit seen, delay shutdown possible
416	"	"	"	"	"			"	"	85		OK	"	5.0	"	Functioned OK
417	"	"	"	"	"			"	"	89		"	"	5.7	"	"
418	"	"	"	"	"			"	"	87		"	"	5.5	"	"
419	"	"	"	"	"			"	"	87		"	"	5.4	"	"
420	"	"	"	"	"			"	"	92		"	"	5.0	"	"
421	"	"	"	"	"			"	"	89		"	"	5.2	"	"
422	"	"	"	"	"			"	"	87		"	"	5.2	"	"
423	"	"	"	"	"			"	"	91		"	"	5.6	"	"

1. All green units
2. Samples pulled at random
3. New First Fire

DATA SHEET

40MM FLOATING FLARE - PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
424	3/13 73	25	20 350μ	30	25 AP 400μ			64	3/4	90		OK	W	5.2	F	Functioned OK
425	"	"	"	"	"			"	"	"		"	"	5.4	"	"
426	"	"	"	"	"			"	"			"	"	5.0	"	"

DATA SHEET

1. All red units
2. New First Fire

40MM FLOATING FLARE - PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
427	3/13 73	40	10 350μ	25	25 AP 50μ			65	3/4	90		OK	W	5.2	F	Functioned OK
428	"	"	"	"	"			"	"	84		"	"	5.5	"	"
429	"	"	"	"	"			"	"	87		"	"	5.3	"	"
430	"	"	"	"	"			"	"	83		"	"	5.6	"	"
431	"	"	"	"	"			"	"	86		"	"	5.0	"	"
432	3/14 73	"	"	"	"			"	"	90		"	"	5.3	"	"
433	"	"	"	"	"			"	"	90		"	"	5.4	"	"
434	"	"	"	"	"			"	"	90		"	"	5.0	"	"
435	3/15/73	"	"	"	"			"	"	83		"	"	5.2	"	"
436	"	"	"	"	"			"	"	85		"	"	5.3	"	"
437	"	"	"	"	"			"	"	88		"	"	5.3	"	"

1. All Red Units
2. New First Fire

DATA SHEET

40MM FLOATING FLARE PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
438	3/16 73	40	10 350 μ	25	25 APP 50 μ			65	3/4	86		OK	W	5.1	F	Functioned OK
439	"	"	"	"	"			"	"	90		"	"	5.0	"	"
440	"	"	"	"	"			"	"	93		"	"	5.5	"	"
441	"	"	"	"	"			"	"	81		"	"	5.5	"	"
442	"	"	"	"	"			"	"	87		"	"	5.4	"	"
443	"	"	"	"	"			"	"	83		"	"	5.3	"	"
444	"	"	"	"	"			"	"	85		"	"	5.3	"	"
445	"	"	"	"	"			"	"	88		"	"	5.4	"	"
446	"	"	"	"	"			"	"	89		"	"	5.1	"	"

1. All yellow Units
2. New First Fire

DATA SHEET

40MM FLOATING FLARE-PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
447	3/20 73	45	15 22μ	25	15 AP 50μ			56	3/4	96		OK	W	OK	F	Functioned OK
448	"	"	"	"	"			"	"	97		"	"	"	"	"
449	"	"	"	"	"			"	"	97		"	"	"	"	"
450	"	"	"	"	"			"	"	97		"	"	"	"	"
451	"	"	"	"	"			"	"	100		"	"	"	"	"
452	3/30/ 73	"	"	"	"			"	"	90+		"	"	"	"	"
453	"	"	"	"	"			"	"	"		"	"	"	"	"
454	"	"	"	"	"			"	"	"		"	"	"	"	"
455	"	"	"	"	"			"	"	"		"	"	"	"	"
456	"	"	"	"	"			"	"	"		"	"	"	"	"

1. All yellow Units
2. New First Fire

40MM FLOATING FLARE PHASE III DEVELOPMENT AND QUALIFICATION TEST DATA

Serial Number	Test Date	Percent Composition						Composition Weight (gms)	First Fire Weight (gms)	Burn Time (seconds)	Burn Rate (in./sec)	Color Quality	Water or Land Test	Delay (sec)	Static or Flight Test	Configuration and/or Remarks
		Nitrate	Magnesium	Binder	Secondary Oxidizer	Coolants	Other Additives									
457	4/2 73	45	15 22μ	25	15 AP 50μ			56	3/4	96		OK	W	OK	F	Functioned OK
458	"	"	"	"	"			"	"	93		"	"	"	"	"
459	"	"	"	"	"			"	"	91		"	"	"	"	"
460	"	"	"	"	"			"	"	93		"	"	"	"	"
461	"	"	"	"	"			"	"	92		"	"	"	"	"